



The Alchemist. Jacques Louis Perée, after David Teniers II, 18-19th century. Harvardsartmuseum.org

Master Thesis

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Alchemy – a forgotten heritage

Exploring the material traces of early modern scientific practices in archaeology

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Abstract

Dette speciale undersøger alkymiens underrepræsentation i nutidig arkæologisk forskning, og adresserer et hul i anerkendelsen af dens materielle spor, samt dens rolle i tidligere videnskabelige praksisser. På trods af alkymiens historiske betydning, har den i høj grad været fraværende i arkæologiske fortolkninger, især i konteksten af dansk materiale. Denne undersøgelse argumenterer for, at fraværet af alkymi i arkæologiske optegnelser ikke skyldes mangel på materielle beviser, men snarere misfortolkninger, utilstrækkelig genkendelse og mangel på kontekstuel forståelse af alkemiske symboler og artefakter.

Gennem undersøgelsen af casestudier fra Jamestown-kolonien i Amerika, Oberstockstall i Østrig og Kværnhusbroen i Danmark, demonstrerer denne afhandling, at der kan findes materielle beviser for alkymi. Artefakter som smeltedigler, glasfragmenter og destillationsudstyr, indeholder vigtige indsigter i alkemiske praksisser. Undersøgelsen afslører desuden, at den alkemiske materiel kultur er mere udbredt, end tidligere antaget, hvor udfordringen ligger i at genkende de unikke kendetegn ved disse artefakter inden for deres symbolske, esoteriske og eksperimentelle kontekster.

Specialet argumenterer for, at alkymiens underrepræsentation ikke er begrænset til dansk arkæologi, men afspejler en bredere international tendens. Mens alkymiens intellektuelle bidrag til moderne videnskab i stigende grad anerkendes, forbliver dens materielle kultur underudforsket i arkæologiske kontekster. Mangel på engagement med alkemiske artefakter og symboler kan tilskrives en begrænset forståelse af alkemiske praksisser, samt en tendens til at undervurdere dens indflydelse på tidlig eksperimentel videnskab og metalforarbejdning.

Ved at tilbyde en mere nuanceret tilgang til alkemisk materiel kultur, sigter dette speciale mod at berige vores forståelse af den tidlige moderne videnskab, og fremhæve sammenhængen mellem materiel kultur, filosofi og spiritualitet i formningen af intellektuel historie. Alkemiske spor er ofte skjult i oversete artefakter, der kræver specialiseret viden for korrekt identifikation, og understreger behovet for en mere integreret tilgang i fremtidig arkæologisk forskning.

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Introduction

Alchemy, shrouded in mystery and rich with mysticism, has captivated the imagination of scholars, scientists, and those drawn to the arcane for centuries. This practice, which spans cultures and eras, offers rare glimpses into humanity's deepest desires, the longing for immortality, the quest to understand the hidden laws of nature and the pursuit of self-transformation. Its roots can be traced back to the hellenistic world, with notable contributions from Egyptian, Greek, Islamic, and medieval European scholars, each adding complexity to the tradition. Alchemy's relevance to archaeology is tied to its role in historical and technological practices. Together, these perspectives help contextualize alchemy's material, cognitive, and practical dimensions in archaeological study.

1.1. Research question

Despite its extensive historical influence and significance, alchemy is notably absent in contemporary archaeological discussions. This absence raises a fundamental question regarding why alchemy is not acknowledged as a significant subject within the field of archaeology. The core issue addressed by this study, is whether alchemy is underrepresented in archaeology due to lack of material evidence of its existence, or because of a deficiency in understanding what to look for. Additionally, this thesis seeks to determine if the absence of alchemy in archaeological records is a phenomenon unique to Danish archaeological materials, or if it represents a broader tendency across international scholarship.

This study hypothesizes that material evidence for alchemy exists, but has either not been correctly identified or has been misinterpreted as more ordinary objects. Alchemical symbols and tools are likely present at archaeological sites, but require specific knowledge and contextual understanding to be accurately identified. Furthermore, a lack of knowledge may have resulted in differing conditions for the preservation and archaeological discovery of alchemical traces. Therefore, the objective of this study is to elucidate the reasons for the underrepresentation of alchemy in archaeological records by examining potential material evidence, symbols, and themes associated with alchemy from a selection of locations: The Jamestown Colony in America (1607), Oberstockstall in Austria (16th century) and Kværnhusbroen in Denmark (1600-1750) (Johansen, 2010; Veronesi, 2021), will serve as the primary focus of this analysis.

1.2. Alchemy's historical roots and development

For most, alchemy conjures up vivid and distinct imagery. We often link alchemy more to mystical practices and magical lore, than to science and logical analysis. We envision the alchemist as a mysterious, perhaps eccentric figure. In reality, alchemy encompasses much more, with a rich history spanning at least a millennium. It is a discipline that has travelled across nations and evolved. Alchemy paved the way for the development of modern chemistry as we know it today.

To trace the origins of alchemy, we must start in Egypt, which was influenced by Hellenization following Alexander the Great's conquest around 334-323 BC (Fabricius, 1989; Gosden, 2021; L. M. Principe, 2013, p. 9). Egyptians had long been refining techniques for smelting metals and glass, showcasing their advanced skills in these areas over four thousand years before the term "chemistry" was introduced (Fabricius, 1989; L. M. Principe, 2013, pp. 9–10). Fast forward to approximately 750-1400 CE, the Islamic world made significant strides in alchemy, with advancements in medicine, science, and mathematics. The knowledge and expertise developed during this time later took root and greatly impressed medieval Europeans in the twelfth century (Fabricius, 1989; L. M. Principe, 2013, p. 27; Veronesi, 2021). Unfortunately, this period and the scientists associated with it appear to have been overlooked and forgotten since. It was not until the late nineteenth century that historians began studying the Arabic alchemical texts once again (L. M. Principe, 2013, p. 27).

Alchemy entered European scholarship around 1144 with the translation of the Arabic text *De compositione alchemiae* by the English monk Robert of Chester (L. M. Principe, 2013, p. 51). In the prologue of his translation, Robert explained that the reason for this translation was the significant lack of knowledge about alchemy, a statement this thesis will still support today. Following this translation, alchemy experienced a flourishing period of over 600 years, which paved the way for modern science, notably chemistry (L. M. Principe, 2013, p. 51; Veronesi, 2021).

Europe was expanding, not only in new ways of thinking but also geographically. Through this geographical expansion into Islamic territories, the Arabic scholar's wealth of knowledge in medicine, botany, physics, engineering, and many other fields was acquired and quickly embraced by Europe. Additionally, these expansions and travels brought Arabic and ancient Greek knowledge into the predominantly Latin-speaking world, opening up a new realm of understanding through

translations (L. M. Principe, 2013, p. 52). Soon, an increasing number of alchemical texts were translated, significantly expanding the field.

Between 1250 and 1400, shortly after alchemy re-emerged in Western Europe, alchemists sought to defend their practice as legitimate, initially through theological justifications and later by using Christian metaphors and symbols (Matus, 2012; L. M. Principe, 2013). By the 14th century, many alchemists used religious imagery to frame alchemical transmutations within Christian beliefs, aligning such transmutations to Christian miracles such as the Resurrection and the virgin birth (Fabricius, 1989; Matus, 2012; L. M. Principe, 2013). This practice gave alchemy a distinctly Christian idiom, though it sometimes obscured the technical details of the processes involved (Matus, 2012).

As time passed, the debate around alchemy touched on issues regarding the nature of technology and its relationship to the natural world. As alchemy navigated controversies of its legitimacy, its practitioners adopted greater secrecy and began intertwining their craft with Christian theology, shaping the field in ways that would endure for centuries (L. M. Principe, 2013, p. 61). It is not inconceivable that it was this evolution that contributed to alchemy's development into the secretive and mystical discipline that it is widely recognized as today, and laid the foundation for the separation of alchemy as "hocus pocus" from the natural sciences: those clear, empirical, evidence testing disciplines we know today.

1.3. The material and Technological relevance of alchemy to archaeology

From an archaeological perspective, alchemy is primarily relevant, because of its connection to the material world. Alchemical practices were connected to technologies such as metallurgy, glassmaking, ceramics. Archaeological investigations of alchemical sites and workshops will have the potential to shed light on the technical expertise of past societies, providing insights into the development of technologies that laid the groundwork for modern science.

However, alchemy's materiality is not just limited to its tools and substances; it also extends to the production of illustrations, symbols, and laboratory equipment. Alchemical texts, often written in cryptic scripts, are full of symbolic representations of substances, processes, the magical, and the mystical. These texts were not just philosophical, they were often practical guides that included

instructions and illustrations for the construction of specific tools, such as furnaces and distillation equipments. The discovery and analysis of such objects in archaeological contexts will help us better understand the technological capabilities and the environments in which they operated.

One of the most significant archaeological contributions to the study of alchemy is the excavation of workshops, laboratories, and material remnants that provide tangible evidence of alchemical practices (Johansen, 2010; Martínón-Torres & Rehren, 2009; Veronesi, 2023b). Archaeologists have, through the years, uncovered alchemical remnants, including furnaces, alembics, crucibles, and glassware used for distillation and other chemical processes (Johansen, 2010; Martínón-Torres et al., 2003; Martínón-Torres & Rehren, 2005, 2009; Veronesi, 2021). These types of finds allow scholars, including archaeologists, to reconstruct the day-to-day activities of alchemists, potentially revealing aspects of their practical knowledge of materials and their technical skill in manipulating substances. By studying the physical remains of alchemical workspaces, we can trace the evolution of technologies such as metallurgy and glassmaking (Martínón-Torres & Rehren, 2005; Rehren, 2024; Veronesi, 2023a).

The production of materials such as dyes, inks, and medicinal compounds is another area where alchemy intersects with archaeology (Norn et al., 2008; Verna, 2023). Traces of these substances on archaeological artifacts may offer insights into the trade networks, economies, and intellectual exchanges between different regions and cultures.

1.4. Alchemy as a cognitive and symbolic system in Archaeology

However, alchemy's relevance to archaeology is not confined to its material and technological aspects. It also provides a window into the cognitive and symbolic worlds of past societies. Alchemy, like religion, was a way of understanding and interacting with the natural world. Alchemists viewed their work as not merely transforming physical substances but as engaging in a metaphysical process that mirrored the transformation of the soul (L. M. Principe, 2013; Raff, 2000, pp. 160–252). Most famous in the study of alchemy is the quest for the philosopher's stone (Raff, 2000, pp. 160–252). This quest can be seen as both a search for a material that could perfect metals, and a metaphor for spiritual enlightenment.

Alchemy was thus deeply intertwined with the broader intellectual and religious currents of the societies in which it flourished. Alchemy's esoteric symbolism, often framed in religious or mystical language, reflects the attempts of past peoples to understand questions of creation, transformation, and the nature of matter (L. M. Principe, 2013; Raff, 2000).

Archaeological findings of alchemical manuscripts and symbolic imagery offer insights into how these ideas were circulated and understood. Symbols such as the ouroboros – a snake eating its tail, the philosopher's stone, and the four elements (Franz, 1980) often recur in alchemical texts and art. These symbols, when found in archaeological contexts, whether inscribed on objects, depicted in artwork, or described in texts, may help archaeologists reconstruct both the ideologies and the technologies that shaped the practice of alchemy

1.5. The impact of alchemy on archaeological studies

Alchemy is also relevant to archaeology because of its intellectual and cultural significance. Alchemical ideas contributed to early scientific thought and were part of the intellectual background of scholars, artisans, and religious figures across different historical periods (L. M. Principe, 2013). For example, as previously mentioned, the translation of Arabic alchemical texts into Latin during the medieval period, played a crucial role in the transmission of knowledge from the Islamic world to Europe (L. M. Principe, 2013).

Alchemy's relevance to archaeology lies in its rich intersection of material, cognitive, and symbolic dimensions. As both a practical and intellectual tradition, alchemy provides archaeologists with valuable insights into the technological advances, spiritual beliefs, and intellectual frameworks of past societies. By examining the material remains of alchemical practices, whether in the form of laboratories, tools, or symbolic artifacts, archaeologists can reconstruct the processes and shed light on the cultural and historical significance of alchemy.

1.6. The structure of the thesis

This thesis explores the intersection of alchemy and archaeology. It begins with a historical introduction to alchemy, a brief account of its relevance to archaeology, and its symbolic and cognitive significance. The theoretical framework integrates materiality, cognitive archaeology, and

practice theory to examine alchemy as both a cognitive and cultural system. The methodology section presents the research methods, including artifact analysis, historiography, and interpretation.

The central analysis is built around three case studies: the first investigates alchemical laboratories in Jamestown and Oberstockstall through material evidence such as crucibles and glass fragments. The second focuses on alchemical illustrations and their role in interpreting alchemy, while the third examines Denmark's alchemical legacy, particularly through artifacts linked to Kvæsthusbroen and Tycho Brahe.

For my final analysis, I will focus on the Bjørnkær set, which initially captured my interest and prompted my exploration into alchemy. The set was listed on the National Museum's website with a brief mention of its alchemical associations, yet without offering an explanation for this connection. Intrigued by the limited information available, I arranged a visit to the museum to examine the set firsthand, hoping to uncover its alchemical relevance. Since then, the set has been removed from the museum's website, and the reason for its removal remains unclear. This has only deepened my curiosity and ambition to investigate its significance in the context of alchemy.

The discussion synthesizes these findings, exploring themes including the portrayal of alchemists, the role of women in alchemy, and how modern narratives of alchemy can be challenged. Finally, the thesis concludes with a summary of key insights and perspectives for future research.

Theoretical framework

Alchemy, as both a practical and philosophical tradition, offers a unique intersection of materials, practices, and beliefs. To fully understand the role of alchemy in past societies, we need to draw from interdisciplinary theoretical perspectives. This thesis will focus on three primary theoretical frameworks: Materiality theory, cognitive archaeology, and practice theory.

2.1. Materiality theory in the study of alchemy

Materiality theory is a broad approach that emphasizes the relationship between humans and the material world, particularly how objects, materials are shaped by human actions, beliefs, and experiences (Bille & Sørensen, 2019, pp. 16–19). In archaeology, materiality allows us to examine

artifacts not merely as passive residues of past activities, but as active participants in the social and cultural life of the people who created and used them. This theoretical approach moves beyond the notion of objects as static and instead suggests that materials have agency in influencing social practices and cognitive processes (Bille & Sørensen, 2019; Johnson, 2020). Another way of looking at this, is to look at objects as accumulating histories, even acquiring a biography (Gosden & Marshall, 1999).

Alchemy is inherently concerned with the transformation of materials, often described as the quest for turning base metals into noble ones, such as lead into gold (Bayley et al., 2001; Martín-Torres & Rehren, 2005). By applying materiality theory, we can explore how these materials were perceived in alchemical traditions, and how they were filled with symbolic meanings. Through materiality theory, we can consider how alchemists engaged with these substances as active agents in their rituals of transformation. Materiality theory helps us understand how the objects used in alchemy were seen as possessing their own agency, capable of being transformed but also influencing the alchemist's actions and thoughts (Franz, 1980, 1997). Sometimes, it is necessary to understand an object's history in order to understand the people who made and used those objects (Gosden & Marshall, 1999).

Materiality theory is particularly suitable for this thesis, since the main focus of the thesis is on the investigation of material objects such as crucibles, glass apparatus, and distillation sets. By focusing on the materials themselves, we can gain a deeper understanding of the alchemist's view. This perspective allows us to consider not only how these materials were used, but also how they were understood in relation to broader systems, such as religion, nature and philosophy (Franz, 1980, 1997; L. M. Principe, 2013).

2.2. Cognitive archaeology and the the intellectual framework of alchemy

Cognitive archaeology is about understanding the cognitive processes and symbolic systems that influenced human behaviour in the past. It seeks to reconstruct how ancient peoples thought, how they made sense of their world, and how these thoughts were reflected in their material culture, as an example through symbols, which will be further discussed later in the thesis (Ackooy, 2016; Johnson, 2020, p. 94; Newman et al., 2009; Renfrew & Bahn, 2016, p. 391).

Cognitive archaeology is particularly useful in exploring areas of human life that are not limited to functionality, but also belief systems and rituals, areas of importance when studying alchemy, because of its many secrets and unspoken rules. Rituals, symbols and motifs with underlying and often tacit meanings. This will be the primary focus of Case 2, which focuses on alchemical illustrations. By analyzing the illustrations through an iconographic approach, cognitive archaeology seeks to uncover the underlying thought processes that shaped human behavior, potentially offering deeper insights into aspects of alchemy, such as the design and function of laboratories (Johnson, 2020, pp. 94–99; Renfrew & Bahn, 2016, pp. 391–393).

Alchemy is as much a cognitive and philosophical system as it is a practical one (Franz, 1980, 1997; Principe, 2013). Alchemists believed in the existence of hidden properties in nature and the possibility of transforming on a spiritual level (Franz, 1997). Alchemical texts and symbols often represent complex metaphysical concepts that need to be interpreted within the cultural and intellectual context of the period they were written or illustrated, which forms the basis for a section in the discussion that explores how alchemists were depicted and perceived. Cognitive archaeology provides a framework for examining these illustrations and symbols and the historical and social context, in which they were made, allowing us to reconstruct the thoughts and symbolic associations that formed alchemical practices (Fabricius, 1989; L. M. Principe, 2013; Renfrew & Bahn, 2016, pp. 391–393). Through this approach, we can gain insights into how they conceived the material world.

2.3. Practise theory and alchemical labor

(...) any given object, be it a battleship, a hammer, or a stone picked up from the ground, is always a product of its fabrication or use, through gestures, skills, and knowledge which may vary from one culture to another. In other words, techniques are as responsible for producing social ties and types of information as they are for transforming the material world.” (Lemonnier, 2012)

Practice theory focuses on the routine practices and actions that constitute social life. It emphasizes the importance of embodied knowledge, the understanding of how to do things, and the ways in which these practices reproduce social structures (Lemonnier, 2012; Wenger, 1998). In archaeology, practice theory is often used to analyse how everyday activities, including craft production, religious

rituals, and domestic tasks, contribute to the formation of identities, social hierarchies, and cultural norms. (Moran, 2005; L. M. Principe, 2013; Wenger, 1998)

Alchemists had to develop a practical, embodied understanding of how materials behaved under different conditions, knowledge that could not be fully conveyed through texts or diagrams. To work so closely with materials is almost inevitably to be led into secrecy and the unspoken. Through practice theory, we can explore how the physical act of alchemy contributed to the creation of alchemical knowledge, and how the repetitive nature of alchemical work may have reinforced particular social and philosophical ideas (Moran, 2005; Wenger, 1998). This will be the focus of Case 3, where the Danish Bjørnkær set is examined to investigate how it was used and whether or not this specific technology and knowledge can be directly connected to alchemy (Roesdahl, 2014).

Practice theory is an appropriate framework for studying alchemy because it emphasizes the importance of embodied, practical knowledge in the creation and transmission of cultural traditions and knowledge (Lemonnier, 2012; Wenger, 1998). Alchemy is as already established, not just a set of abstract theories about the transformation of matter, it was a hands-on practice that required skill, patience, and experience. Alchemical work was often secretive, and those who engaged in it were sometimes regarded with suspicion or reverence (L. M. Principe, 2013). Practice theory provides a way to investigate how alchemical practices contributed to the social identities of alchemists and how these practices were embedded within broader networks of power, knowledge, and status.

Methodology

The interdisciplinary study of alchemy within an archaeological context necessitates a combination of methodological approaches that draw on both the humanities and the sciences. To investigate alchemical practices, archaeologists must examine a wide range of evidence, from material culture such as crucibles, distillation equipment, and alchemical tools, to architectural remains and visual symbols. Together, the following methods are crucial for reconstructing alchemy's complex role in history and its material manifestations, making them indispensable for a comprehensive archaeological study.

3.1. Archaeological methods: artifact analysis

Archaeology is centered on understanding how objects were used in the past. Archaeologists examine artifacts to determine how, why, and by whom they were utilized, aiming to uncover the roles these items played in daily life and their connection to their surroundings. Context helps to tell stories about how people lived and interacted, shedding light on their use of various items, and through this, their perspectives on religion, work, social status, and more (Renfrew & Bahn, 2016; Wenger, 1998). Archaeology employs a wide range of methods for artifact analysis, from basic typology to advanced scientific testing, both of which will be of focus throughout the analysis of the artifacts.

It is a remarkable paradox that analytical chemistry, which significantly contributed to refuting the alchemical belief in the possibility of transmutation of matter, helps us to better understand alchemical theories and paradigms. (Chalupa & Nesměrák, 2021)

Historically, research on alchemy has primarily been limited to studying historical texts and descriptions of preserved artifacts (Becker, 1938; Martínón-Torres, 2011; Newman, 2011). Today however, people researching alchemy are collaborating across disciplines, including with analytical chemists (Chalupa & Nesměrák, 2021; T. E. Nummedal, 2011). By analyzing preserved objects like crucibles and glass apparatuses (see case 1 and 3), we get closer to answering questions about alchemical practices with much greater accuracy. At the same time, replicating alchemical experiments, such as with the Bjørnkær set (see case 3), allows for better interpretation and understanding of alchemical knowledge (Chalupa & Nesměrák, 2021; Johansen, 2010; Roesdahl, 2014; Veronesi, 2021).

However, performing chemical analyses is not always an option, so it's helpful that archaeology has a wide range of other methods for dating artifacts. Typically, an archaeologist will examine the typology, material, size, shape, and decorations of the object (Renfrew & Bahn, 2016, p. 133; Veronesi, 2023a). When it comes to the study of alchemy, it can be challenging. To properly use typological dating, a sufficient amount of material must be analyzed to place the objects in a context (Martínón-Torres et al., 2003; Renfrew & Bahn, 2016, p. 133; Veronesi, 2021). The issue with alchemical artifacts, however, is that they are rare, which raises one of the key questions in this thesis: are there so few because we don't yet understand the typology, because they haven't been sufficiently analyzed, or because the artifacts simply are no longer here?

3.2. Historical methods: historiography

It is not only the study of the artifacts that is important. It is equally as important to analyse and understand the written and understood about the artifacts and their time (Becker, 1938). Scholars are constantly at risk of transferring their own knowledge and experiences unconsciously in their interpretations of artefacts and historical periods (Becker, 1938; Newman, 2011). Every scholar, whether historian or archaeologist, is biased in their understandings. We make assumptions and interpret what things in the past was like, based on how things are today (Johnson, 2020, p. 54). That is why it is important to examine things from different perspectives. Historiography is about the written history, and how different historians, interpret things differently, based on backgrounds, beliefs and most importantly, the time period in which they were written (Becker, 1938; Newman, 2011). Due to the lack of alchemical artifacts, it is crucial to look at written works, and how the approach to alchemy has changed through out time, to better avoid letting contemporary beliefs interfere with interpretations, and rather understand that there are different understandings of alchemy (Martínón-Torres, 2011; Newman & Principe, 1998). At the same time, looking at historiography provides insight into how things may have been used, which is invaluable to the combined knowledge of the artifacts themselves.

In this thesis, significant focus will be placed on the historical perspective within archaeology, particularly through a dedicated section that delves deeper into the historiography of alchemy (Martínón-Torres, 2011). As briefly mentioned earlier, alchemy has been part of history for many years, experiencing periods of significant development and praise, as well as times of controversy and undermining (L. M. Principe, 2013).

For archaeologists, it is essential not only to understand the historical context of alchemy to grasp its practical applications, but also to trace its evolution in order to better comprehend its current state and relevance.

3.3. Symbolic and semiotic: iconographic and semiotic analysis

Later in the analysis, the focus will shift to alchemical illustrations and depictions, examining how these visual sources and the motifs they contain functioned within the framework of alchemical thought. This approach will aim towards further demonstrating how the symbols, recurring themes,

and imagery on these illustrations were used as part of a broader communicative system, offering insights into the intellectual and spiritual practices of alchemists

Alchemy is concerned with the self and with its creation, and its symbols depict the experience of active imagination and the transcendent function (Raff, 2000, p. 37)

Another way of interpreting the archaeological records beyond the physical remains, is through symbols and signs. Through iconographic and semiotic analysing, we gain insight into the symbolic meanings assigned to artifacts by their creators. In archaeology, iconography is typically used to explore themes like religions, power and identity. This is by identifying recurring motifs and examining styles, essentially allowing the archaeologist to understand how society viewed itself through their symbolic meanings (Fabricius, 1989; Newman et al., 2009). Equally, it's about examining how these motifs communicate messages and meanings, how artifacts and illustrations functioned within communicative systems, serving as tools for expressing beliefs, ideologies, social roles or relationships. Alchemist used symbols as a form of unspoken communication (Fabricius, 1989; Franz, 1980; Newman et al., 2009; Raff, 2000, p. 38).

“When the alchemist spoke of the stars, there was always a reference to astrology, for they believed that the stars and planets influenced the formation of metals in the center of the earth, and also affected to destiny of a human being” (Raff, 2000, p. 70)

Through drawings and illustrations, it was possible for the alchemist to illuminate the secret and mystical aspects of the discipline. However, it was not only in the written form that symbols proved to be useful. Symbols could also be used on the objects themselves, for example, on crucibles to indicate their use and the manufacturers (Johansen, 2010; Newman et al., 2009).

From mysticism to modern chemistry: alchemy's evolving legacy

This chapter explores the evolving historiography of alchemy, examining how scholars have debated its relationship to modern chemistry and its broader cultural and spiritual significance. While some view alchemy as a precursor to chemistry, others argue that it represents a distinct tradition that blends experimental science with mystical and spiritual elements. Additionally, the role of religion and Christian metaphors in alchemical thought is crucial to understanding its complex legacy. This chapter will delve into these different perspectives, offering an interdisciplinary approach to better grasp alchemy's multifaceted contributions to both science and spirituality, to support future analyses later in the thesis.

4.1. The archaeology and historiography of alchemy

4.1.1. "Alchemy" and "chemistry"

Defining alchemy has posed a persistent challenge in historiography due to its fluid boundaries and its close relationship with chemistry. The difficulty arises from the fact that, in early modern Europe, the terms "alchemy" and "chemistry" were often used interchangeably, reflecting a conceptual overlap that complicates modern attempts to differentiate them. Historians grapple with whether alchemy was a distinct field, focused on spiritual transformation and esoteric goals, or simply an early stage of experimental science that later evolved into modern chemistry (Burnett & Moureau, 2023; Chalupa & Nesměrák, 2021; Newman & Principe, 1998). Modern scholarship tends to separate alchemy as spiritual, mysterious and sometimes as non-scientific. This lack of differentiation creates challenges when discussing theories, texts, or practices from this period, because terms were often used interchangeably (Newman & Principe, 1998). Attempts to separate them retrospectively have led to misinterpretations that don't align with historical records (Newman & Principe, 1998). Such categorization risks reinforcing contemporary definitions rather than reflecting historical realities, blurring any distinction between alchemy and chemistry.

In an attempt to clarify the terminology of alchemy, William R. Newman and Lawrence M. Principe, attempted to differentiate alchemy from chemistry based on historical figures and their works,

discussing why it is a historiographic mistake that such a distinction of the two words existed before the eighteenth century (Newman & Principe, 1998).

Originating from the Greek terms *chēmeia* or *chymeia*, derived from the word for smelting metals *cheein*, later appropriated by the Arabs, who added the definite noun *al* to *kīmiyā*, leading to the word *al-kīmiyā*, precursor to the Latin *alchymia*, and its variants *alchemia* and *achimia* (Newman & Principe, 1998, p. 38). It was not until around 1720, that the words “alchemy”, defined by being the discipline of transmuting metals, and “chemistry”, the art of analysis and synthesis, acquired more divided terminologies, relating more to their modern meanings (Newman & Principe, 1998, pp. 39–40). It is necessary to understand this distinction, or rather lack of, to access the archaeological materials in a context of both, and not as two separate disciplines.

To an archaeologist, it's clear that chemistry plays a vital role in deepening our understanding of the past. The material traces we uncover—fragments of pottery, metal tools, glassware, or even organic remains—are not just objects; they are vessels of information. Chemistry allows us to analyze these materials at a molecular level, revealing how they were made, where they came from, and how they were used (Johnson, 2020; Renfrew & Bahn, 2016; Veronesi, 2021). Given this, it is essential to place more focus on studying and unveiling the history of sciences, such as alchemy. It makes sense that more research focus should be placed on studying the history and development of the natural science methods we use today, such as chemistry.

4.1.2. The historiography

More recently, critics of more recent works on the historiography of alchemy, have reasserted the stereotypical view of alchemy, as a structure that has contributed very little to modern chemistry, proving that the history of alchemy continues to evoke controversies and discussion, struggling to deviate from ongoing stereotypes (Newman, 2011, pp. 313–314). Early chemistry, particularly through alchemy, developed alongside other sciences but in a unique way, blending empirical practices with spiritual and mystical elements. Unlike other fields, it integrated both material experimentation and philosophical inquiry, which allowed it to persist and evolve in parallel with the more modern, empirical sciences (Newman, 2006; Newman & Principe, 1998; Runstedler, 2023).

To clarify, science is defined as methods of investigation and knowledge acquisition based on observation, experimentation, and logical reasoning. It is often associated with a systematic approach to understanding the natural world (*SCIENCE | Cambridge Dictionary*). In archaeology, scientific methods involve applying techniques like radiocarbon dating, chemical analysis, and geophysical surveys to study past human cultures and their material remains (Renfrew & Bahn, 2016).

The historiography of alchemy includes two primary interpretations: one sees alchemy as the precursor to modern chemistry, primarily studied within the context of scientific history and laboratory practices by scholars trained in chemistry and related fields (Newman & Principe, 1998). Conversely, another interpretation, often termed “spiritual alchemy,” considers alchemy through various lenses, including religious behaviour, psychology, esotericism, hermetic tradition, and hermeneutics (Calian, 2010).

Philosopher Florin G. Calian, in contrast to Newman and Principe’s more chemistry related historiography, explores modern controversies surrounding the historiography of alchemy more towards the spiritual interpretation, primarily through the perspectives of Carl Gustav Jung and Mircea Eliade (Calian, 2010). Calian explains Jung viewed alchemy as significant to psychology, interpreting its symbols as reflections of psychological development rather than merely laboratory work. He explains that Jung believed alchemical texts project internal psychological states, and represent a reality of the psyche, emphasizing a connection between the decline of alchemy and the rise of chemistry, while asserting that the spiritual aspects of alchemy persist despite being challenged by scientific developments (Calian, 2010, pp. 167–169).

In contrast, Eliade framed alchemy as a religious phenomenon, linking it to primitive societies interactions with matter. Eliade argued that alchemy transcends mere scientific inquiry, emphasizing its spiritual dimensions and the alchemist's role in transforming both matter and the self. Eliade focused on various cultural expressions of alchemical thought, suggesting that alchemical practices reflect a deep engagement with mysticism and nature (Calian, 2010, pp. 169–170). Calian argues that viewing alchemy solely from a scientific perspective limits understanding of its broader historical and cultural implications (Calian, 2010).

Calian goes on to suggest an ahistorical approach. Calian also critiques Jung's approach to the historiography of alchemy, highlighting the lack of a clearly defined historical framework in his work, by merging medieval and Renaissance alchemical ideas in a way that obscures their historical contexts, interpreting them as manifestations of universal psychological dispositions rather than products of specific cultural and historical conditions (Calian, 2010, p. 172). Principe and Newman have rejected Jung's psychological interpretation, arguing that Jung's views have become unchallenged "self-evident truths" among alchemy historians (Calian, 2010, p. 172).

From an archaeological perspective, studying alchemy requires a balanced view that considers both its scientific and spiritual dimensions. The material culture of alchemy—such as tools, manuscripts, and residues—provides insights into early scientific practices that prefigured modern chemistry, as well as the spiritual and psychological beliefs intertwined with alchemical thought. Moreover, I would argue that this approach could explain why the archaeological remnants of alchemy seem to have vanished. Alchemical artifacts may have been viewed as a singular entity, but they actually represent a multitude of distinct aspects, likely disappearing due to misclassification or an oversimplified categorization. By recognizing the complexity of alchemy, we can better understand its material legacy and its profound impact on both science and culture.

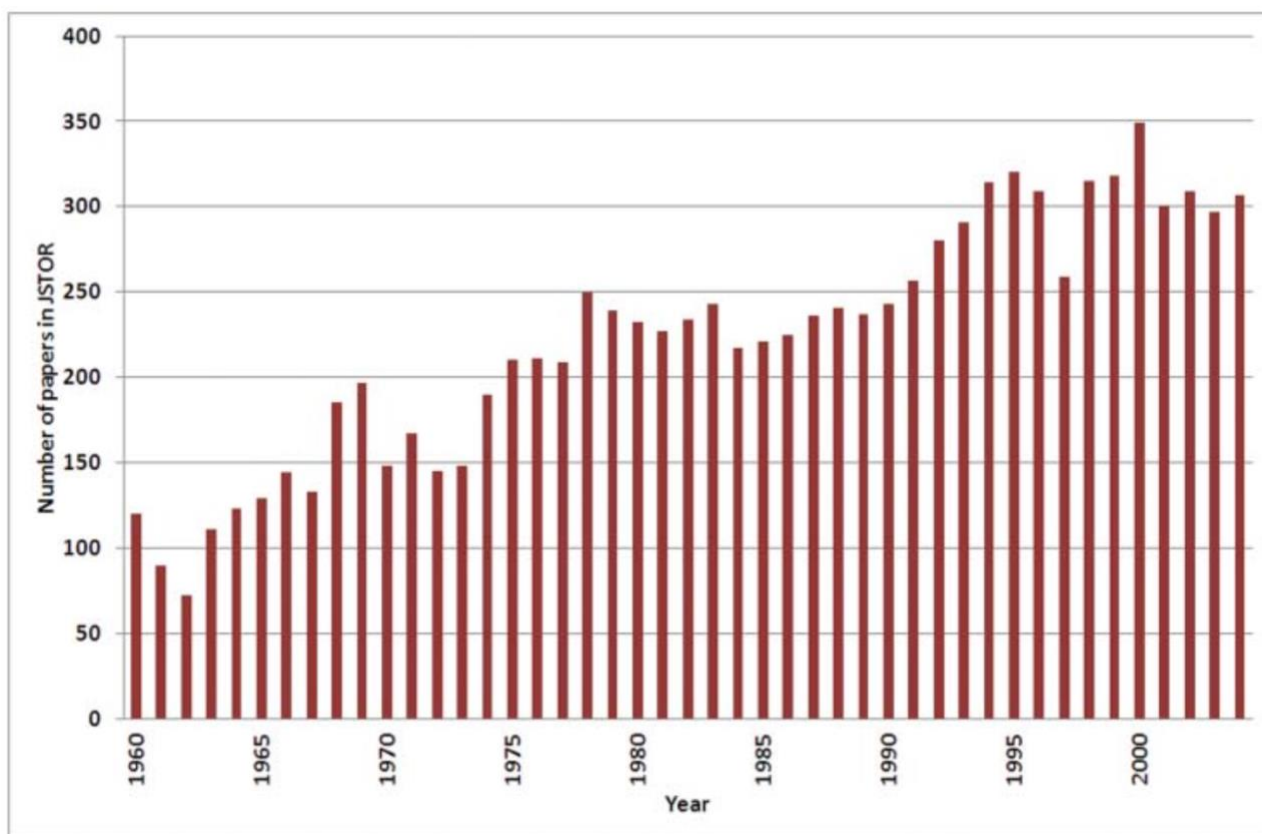


Figure 1. Frequency histogram for the number of papers containing the term “alchem-” published between 1960 and 2004. (Martín-Torres, 2011, p. 217).

4.1.3. Academic engagement

The history of alchemy has seen a resurgence in interest since the mid-2000s, highlighted by major conferences in Philadelphia and Madrid and numerous workshops across Europe (Martín-Torres, 2011). This growing academic engagement is reflected in an increase in publications on the subject. As the Society for the History of Alchemy and Chemistry marked its seventy-fifth anniversary in 2013, archaeologist Marcos Martín-Torres has reviewed key developments in alchemical historiography over the past two decades, focusing on significant contributions and ongoing research trends (Martín-Torres, 2011, pp. 215–217).

Figure 1 highlights an intriguing reality. A significant amount of work has been produced on alchemy in various forms. An interesting example in the context of this thesis, as it clearly demonstrates an interest in the field, which in turn raises the intriguing question of why it remains so under-discussed in archaeology. How is it that so much work has been conducted on the topic, yet it appears to remain primarily within the realm of historians, without being fully integrated into archaeology. Martín-

Torres examines the impactful paper by Newman and Principe, two historians renowned for their significant contributions to the historiography of alchemy, titled "Alchemy vs. Chemistry: The Etymological Origins of a Historiographic Mistake." Their work, which serves as a key foundation for this thesis, has played a central role in shaping what they call the "New Historiography" of alchemy, advocating for the term "chymistry" as a more inclusive alternative (Martín-Torres, 2011, pp. 220–222; Newman, 2006; Newman & Principe, 1998; L. M. Principe, 2013).

Martín-Torres further highlights ongoing critiques of this approach, while emphasizing the importance of diverse perspectives in the historiography of alchemy. He argues that alchemists engaged in practical work while also contributing to the scientific method and the roots of the Scientific Revolution (Martín-Torres, 2011). Recent research highlights the significant role of alchemy and its methodologies in shaping modern science, particularly in the works of influential figures like Boyle and Newton, while also showing that elements such as religion and magic were integral to early scientific inquiry rather than obstacles to it (Burnett & Moureau, 2023; Calian, 2010; Martín-Torres, 2011, pp. 222–226; Newman & Principe, 1998). Martín-Torres reviews recent advancements in the historiography of alchemy, acknowledging the contributions of past scholars, while also suggesting that current research should avoid isolated case studies, and instead focus on broader connections across disciplines. He highlights the need for interdisciplinary approaches, combining historical research with scientific knowledge, to better understand the interplay of alchemical theory and practice (Martín-Torres, 2011, pp. 234–237). This thesis aligns with Martín-Torres' call for an interdisciplinary approach to alchemy, combining both scientific artifact-focused methods and semiotic analysis of visual sources.

Newman and Principe have sought to clarify this terminology, arguing that a clear distinction between alchemy and chemistry emerged only in the early 18th century (Newman & Principe, 1998). This view supports the idea that alchemy cannot be easily separated from early chemistry, as both disciplines were intertwined in practice, theory, and terminology. The blurred boundaries challenge the notion of a strict division, emphasizing the need for a more nuanced approach.

Critics continue to stereotype alchemy as having contributed little to modern chemistry, highlighting ongoing controversies in its historiography. Additionally, the resurgence of interest in alchemical studies since the mid-2000s underscores the importance of making alchemical history accessible to a

more diverse audiences, such as students like myself, by integrating it into various educational contexts, such as archaeology.

4.2. Archaeological alchemy

(...) it begins with broken crucibles, bits of slag and other residues left behind (...)
(Veronesi, 2023b, p. 343)

The archaeology of alchemy and chemistry has evolved significantly over time, reflecting shifts in both scientific practices and cultural perspectives. One pivotal moment in this development came in the 1980s with the excavation of the Oberstockstall laboratory in Austria, where key alchemical and metallurgical tools—such as furnaces, crucibles, and glass distillation equipment, were uncovered (Veronesi, 2021, 2023a, 2023b). This discovery is essential to understanding early alchemical practices and will be explored further in this thesis, particularly in relation to the concept of laboratories as one of the main focuspoints.

The late 20th and early 21st centuries saw scholars like Thilo Rehren and Marcos Martín-Torres (Martín-Torres & Rehren, 2005, 2007, 2009) expand the study of alchemical materials through scientific analysis. They used advanced techniques to reveal hidden processes within crucibles, furnaces, and residue samples, demonstrating how alchemical and metallurgical practices shared tools and methods despite having distinct goals (Martín-Torres & Rehren, 2005, 2007, 2009).

Crucibles, essential for high-temperature reactions in both metallurgy and chemistry, are a key focus of this study. Research on crucibles uncovered an international trade in crucibles, particularly during the Renaissance, with types like the sand-tempered kaolinitic crucibles from Hesse and smooth graphitic crucibles from Bavaria (Martín-Torres & Rehren, 2007). These differences in material and production processes offer insights into the technological and cultural contexts of the time (Torres, 2009, pp. 60–70).

However, while progress has been made, scholarly attention to alchemical instruments and their production remains limited. Many of these devices, often derived from earlier civilizations, show little technological evolution over time. It is likely that alchemists learned to craft many of their

instruments through personal experience, books, and the practices of their contemporaries (L. M. Principe, 2013; Runstedler, 2023; Wenger, 1998).

4.3. Religion in alchemy

The relationship between alchemy and religion in medieval and early modern Europe reveals a complex tapestry of beliefs, symbolisms, and aspirations that bridged theology, natural philosophy, and eschatology (Martín-Torres, 2011; Matus, 2012; Runstedler, 2023; Wenger, 1998). As alchemy entered western Europe around the 12th century, it became intertwined with Christian thought, often serving as a lens to view natural processes in a theological light. Early alchemists, aiming to legitimize their work, framed it within the Christian worldview, presenting it as compatible with biblical themes, the structure of creation, and divine mysteries (Matus, 2012; T. Nummedal, 2013; L. M. Principe, 2013; Webb, 1985). Figures such as Martin Luther, though not an alchemist, appreciated alchemy's symbolic potential, comparing the purifying flames of alchemical processes to the separation of the righteous from the wicked on the Day of Judgment, such metaphors reflecting how alchemical principles resonated with Christian beliefs, drawing parallels between spiritual purification and material transformation. (Matus, 2012; T. Nummedal, 2013; L. M. Principe, 2013; Webb, 1985). Principe and Newman would agree that alchemy and religion in medieval and early modern Europe were closely linked, because their research emphasizes how alchemy was not merely a mystical pursuit but a legitimate part of early science, intertwined with theological ideas (Newman, 2011; Newman & Principe, 1998).

By the 13th century, alchemical authors actively sought theological justifications for their work, positioning alchemy as aligned with divine order. In the 14th century, alchemical texts became increasingly infused with Christian symbols, with transformations of matter was interpreted as echoes of divine mysteries and miraculous events (Matus, 2012, pp. 934–935; T. E. Nummedal, 2011). Describing alchemical processes in terms of Christ's resurrection or the virgin birth, aimed to frame alchemy as a Christian art, integrating it with doctrines central to the medieval Church (Nummedal, 2011, 2013). Some alchemists drew on these ideas to reflect on figures like Adam, the Virgin Mary, and the saints, seeing their work not only as a form of proto-science but as a medium for exploring the spiritual foundations of the physical world (Nummedal, 2013, pp. 311–319).

Modern historians have examined alchemy's role within the history of science, with scholars such as William Newman and Lawrence Principe challenging the view of alchemy as a purely mystical or occult discipline (Newman & Principe, 1998; T. E. Nummedal, 2011). By analysing alchemical texts through their chemical practices and theological language, they argue that medieval alchemy was both an empirical pursuit and a religious one. Scholars like Barbara Obrist have shown, that the symbolic language in alchemical texts, such as the moon representing silver or the sun symbolizing gold, was metaphorical, yet referred to real compounds and operations understood by those practicing alchemy (Matus, 2012, p. 363; Newman & Principe, 1998). Rather than mystical codes, these symbols often served as accessible analogies, connecting alchemical processes to widely understood Christian metaphors (T. E. Nummedal, 2011).

The English philosopher and monk, Roger Bacon's approach to alchemy provides an interesting intersection between religious thought and alchemical practice. Bacon viewed alchemy as a critical science, central to his reform of medieval thought. He distinguished between *theoretical alchemy*, which explores the generation of substances from the elements, and *practical alchemy*, which focuses on producing materials like metals and pigments (Newman, 1997). Bacon believed that practical alchemy could even surpass nature in creating perfected products. This perspective linked alchemical processes to Christian ideas of purification and divine transformation, positioning alchemy as a bridge between the physical world and divine order (Newman, 1997).

Furthermore, more recent scholarship highlights how medieval alchemy was embedded in the Christian framework, with religious themes representing “period piety” rather than obscure mysticism (Matus, 2012, p. 363). This complex interaction between alchemy and religion reflects a worldview where science and spirituality were not conflicting realms but rather complementary ways of understanding creation. By integrating Christian motifs, alchemists presented their work as both empirical and spiritually significant, echoing a cosmology where the physical and metaphysical worlds were inseparably linked (Matus, 2012; T. E. Nummedal, 2011). This will be exemplified later in Case 2 of the analysis, which demonstrates how one thing can have multiple meanings. Modern scholarship continues to uncover how medieval and early modern alchemy contributed not only to scientific knowledge, but also to theological insights, allowing figures across centuries to explore eschatological, symbolic, and natural mysteries through the transformative lens of alchemical practice.

Alchemy's symbolism serves as a bridge to explore the mysterious qualities of the unconscious mind. Even as chemistry separated from alchemy's mystical framework, alchemical symbols remained influential, representing the underlying unity and hidden potential in nature and the human psyche (Jung, 2014, pp. 432–434). Alchemists believed these symbols revealed essential truths, not as images, but as reflections of human consciousness and its link to the divine. In Christian alchemical traditions, this transforming essence was often paralleled with Christ, inspired by symbols such as the serpent on the cross and other well known religious figures, as previously mentioned (Jung, 2014; T. E. Nummedal, 2011). Through these religious analogies, alchemists sought to understand and reveal the sacred mysteries within both the natural world and the soul.

Religion as demonstrated, plays a vital role in alchemy because it reflects not just the practice itself, but also the values and worldview of the society surrounding it, an invaluable quality that aids archaeologists in understanding objects beyond their mere function. Through religious symbols, alchemy gains a powerful means to illustrate its hidden and transformative processes, aligning perfectly with its secretive, mystical nature. These symbols deepen the mystery, making alchemy not just a scientific pursuit, but a disciplined path requiring both insight and reverence. It is interesting for archaeologists to explore these connection to religion because it reveals more than just the technical processes—it offers a window into the values, beliefs, and worldview of the alchemist.

4.4. Magic, the universe and nature

Alchemy, however, is much more than religion as we know it. Largely based on a hidden language that goes beyond the visible and physical, and its practice involves symbolism, mysteries, and rituals that cannot easily be translated into rational or logical frameworks (Gosden, 2021). For the alchemist, the world is not merely a place for physical events, but a cosmos filled with hidden forces and energies that can be manipulated and understood through the alchemist's inner spiritual journey (Franz, 1980, 1997; Gosden, 2021). The alchemist's tools and understanding of the world are driven by the belief that nature holds hidden forces that can be brought to life through alchemical practices. The alchemist seeks not only to understand the laws of nature but also to transform themselves, both spiritually and physically, through these forces (Franz, 1980, 1997).

When people confront the big issues of life and death, when they desire to know the future or to understand the past, to protect themselves from harm, cure illness or promote well-being they often turn to magic” (Gosden, 2021, p. 1)

A central idea in alchemy is the belief that everything in nature is interconnected, and that all chemistry and magic are expressions of universal laws that transcend the physical realm. This makes alchemy a kind of universal religion in itself, where the alchemist’s work in the laboratory or workshop is not merely a physical activity, but also a metaphysical act that reflects a higher spiritual calling (Franz, 1997; Gosden, 2021). In this sense, alchemy can be seen as an alternative religious path that seeks enlightenment and salvation through personal and spiritual transformation, rather than through external divine intervention (Franz, 1997; Gosden, 2021; Raff, 2000).

So far, we have learned that from an archaeological perspective, there are limitations in how we can interpret the findings. Archaeologists can offer interpretations, but they can never be entirely certain of their conclusions. This underscores the importance of source criticism when analyzing artifacts, especially in the context of this project. The objects we uncover are not always as straightforward as they might initially appear, and their deeper, more complex meanings can be easily overlooked. Thus, while archaeology provides valuable insights, it is crucial to recognize the limitations of our interpretations and understand that what we see is only a small part of a much larger, often hidden, picture.

Case I: Laboratories

In this case, the concept of laboratories is explored from a theoretical and archaeological perspective, with a focus on crucibles and glass fragments. By examining sites like the Jamestown colony and the Oberstockstall laboratory (Martín-Torres & Rehren, 2007; Veronesi, 2021; Veronesi & Martín-Torres, 2018), the purpose, materials, and contexts of these objects are analyzed, shedding light on their role in historical experiments and alchemical processes. The goal is to develop a clearer understanding of what defines a laboratory, how minimal resources can create an experimental space, and to provide guidance for archaeologists identifying traces of alchemical activity.

The analysis draws heavily on the work of key scholars, Umberto Veronesi, Marcos Martín-Torres, and Thilo Rehren, whose research has significantly contributed to integrating alchemy into contemporary discourse. While the primary focus is on crucibles and glass fragments, it is acknowledged that other tools, such as scorifiers and cupels, are also relevant. However, due to space constraints, this thesis prioritizes the two artifacts that are most informative for the discussion.

5.1. The Jamestown colony

5.1.1. Introduction

The founding of Jamestown in 1607 marked the first permanent English settlement in America. The Jamestown colony was established not only as a trading outpost, but also as a site for resource extraction and experimental ventures. While the motivations behind the settlement included the search for precious metals and profitable resources, it also carried underlying connections to alchemical practices (Veronesi, 2021, p. 86). The colony's investors aimed to profit from the discovery of precious metals like gold and silver, as well as other minerals such as zinc and tin, essential for copper metallurgy. Jamestown's colonists brought specialized equipment and trained professionals to assess the mineral resources, including carpenters, masons, tailors, apothecaries, blacksmiths, goldsmiths, assayers, refiners and glassmakers, all know areas of alchemy (Martín-Torres & Rehren, 2007; Veronesi, 2021, pp. 86–87).

Over twenty-five years of excavation have yielded thousands of artifacts at the colony, offering archaeologists a detailed understanding of colonial life and insight into the lives of the individuals who inhabited the settlement. Among these finds, numerous artifacts are linked to the colony's metallurgical and broader artisanal practices. Examples include ceramic crucibles in various sizes

and shapes, fragments of bone ash cupels, specialized ceramic vessels, parts of glass and pottery distillation apparatus, as well as pieces of ore and glass cullet. Archaeologist also found thousands of small copper offcuts or sheets, further indicating work of metallurgy (Veronesi, 2021, p. 90). These materials provide crucial evidence of metallurgists, assayers, refiners, glassmakers, and apothecaries activities within the fort during its early occupation. Many of these chemistry-related artifacts were uncovered within a large dump layer inside what archaeologists have labeled “the factory”, a long building situated on the fort’s perimeter (Veronesi, 2021, p. 90).

For this analysis, Jamestown serves as an example of a site where various branches of alchemy were practiced. Through its artifacts, Jamestown provides insight into the specific tools and materials essential to these different alchemical pursuits. In this analysis, the focus will primarily be on the discovery of crucibles, due to the crucial insights they provide into technological knowledge and their role as key indicators of laboratory activities.

5.1.2. Crucibles



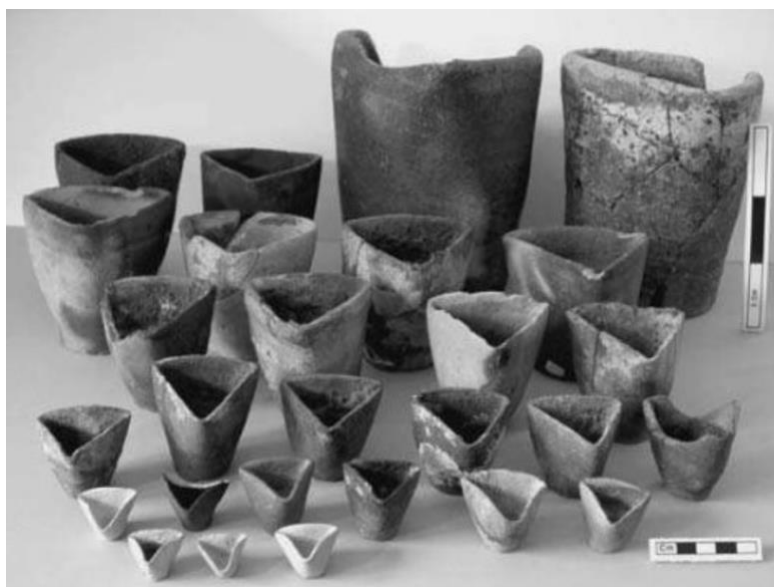
Figur 2: Ceramic crucibles. Hessian type (left) non-Hessian (right). Veronesi, 2021, p. 91.

In simple terms, crucibles are containers designed for use in processes such as metallurgy and glassmaking (Martín-Torres & Rehren, 2009; Veronesi, 2021, 2023a). They are special because they can withstand extremely high temperatures, which is a necessary trait when working with metals. In other words, crucibles are indispensable tools for the production of metals and glass. The high heat required to withstand such processes symbolizes the alchemist's mastery and knowledge of elemental forces, as well as their ability to manipulate and purify matter (Martín-Torres & Rehren, 2009; Veronesi, 2021, 2023a).

Recently, a number of crucibles from the Jamestown colony have been subjected to archaeological investigations (Martín-Torres & Rehren, 2007; Veronesi, 2021, p. 92). These studies revealed that the crucibles were of German origin, imported from the region Hesse, hence the name Hessian type. During this time, hessian crucibles were considered some of the most technically advanced ceramic equipment produced for laboratories worldwide (Veronesi, 2021, p. 92).

Hessian crucibles are typically identified by their triangular shape (see Figure 2 and figure 3), though there are also triangular crucibles that are not from Hesse. Archaeological investigations have shown that the production of these crucibles dates back as early as the 12th century (Martín-Torres & Rehren, 2009, p. 51). The archaeological analysis of the Jamestown crucibles employed advanced techniques such as archaeometry and scanning electron microscopy (SEM) to uncover the materials and residues within the ceramic structures. These methods allowed the researchers to identify traces of metals like copper, zinc, iron, and tin, proving the crucibles use in metallurgical processes, such as the testing and refining of ores in search of precious metals. SEM further revealed the microscopic structure of the clay, providing insight into the crucibles composition and how it was able to withstand the high temperatures (see 5.1.3. for more details on how they were made) (Martín-Torres & Rehren, 2009; Veronesi, 2021, p. 92). The fact that Hessian crucibles, being among the most advanced ceramic instruments of their time, were found at Jamestown, speaks to the presence of highly skilled workers, possibly alchemists or metallurgists if indeed the two can be separated, were performing precise and knowledge rich tasks, such as the extraction and refinement of metals. This kind of expertise, together with the physical evidence left behind in these crucibles, indicates that the colony was not just engaged in basic industrial activities but was also exploring more intricate scientific processes and experimenting with metallurgy (Martín-Torres & Rehren, 2007; Veronesi, 2021).

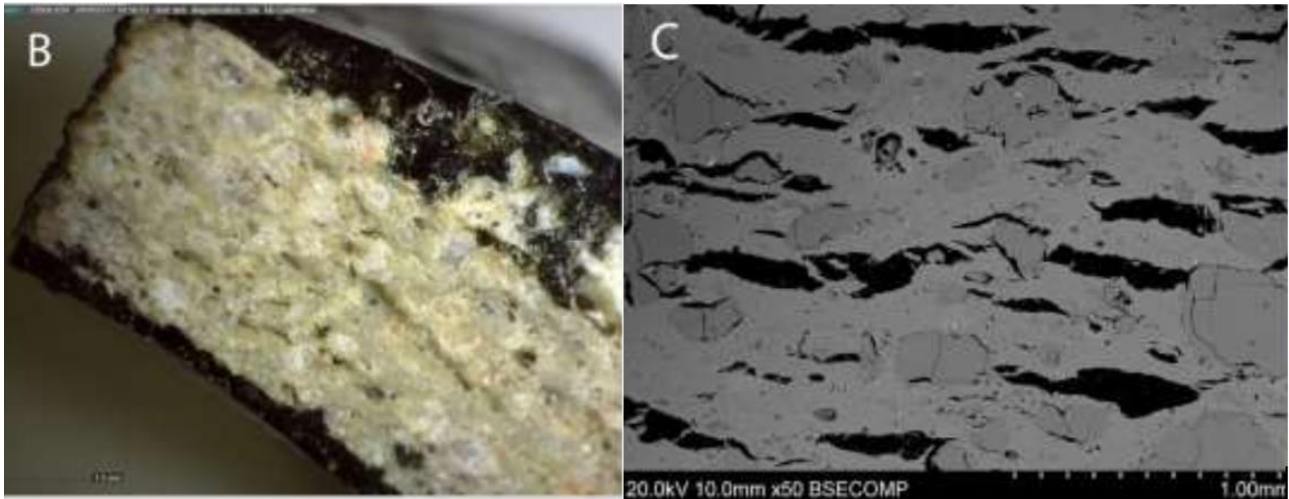
Similar crucibles have been recovered from the alchemical laboratory of Oberstockstall (see figure 3). This particular location will be further discussed later on in the case, however the figure provide a good picture of the variation in crucibles, offering a better overall view.



Figur 3: A selection of triangular crucibles from Oberstockstall - Martín-Torres & Rehren, 2009

5.1.3. How are they made?

Crucibles are generally made from a type of clay rich in alumina, a substance capable of withstanding high heat, and low in oxides, which are less heat-resistant. This combination makes the clay strong enough to handle the extreme temperatures such as required for melting metals. The reason Hessian crucibles are considered the best is due to their exceptionally high alumina content (Martín-Torres & Rehren, 2007; Veronesi, 2023b, p. 66). However, good clay alone is not enough. Often, materials like sand or graphite flakes are added to further enhance the crucibles ability to withstand high heat (see figure 4). This technique has been used in ceramic production for centuries, a technique that prevents the clay from cracking during heating. It also helps to distribute the heat more evenly (Allegretta et al., 2015). Another method, seen in the case of Hessian crucibles, involves pre-firing the clay at temperatures over 1200 degrees, causing the ceramic to vitrify, further enhancing its durability (Allegretta et al., 2015; Veronesi, 2021, p. 66). This knowledge is indispensable for the archaeologist, and for this thesis, as these elements would be the first to be examined before resorting to more chemically analytical methods.



Figur 4: Hessian crucibles from Jamestown. Picture B shows the texture of the clay from a section cut, while picture C shows the effects of the quartz under high magnification, creating elongated voids, making the clay better at withstanding the high heat - Veronesi, 2021, p. 98

Despite being designed to withstand extreme heat, crucibles were often single-use items. In many cases, the crucible had to be destroyed after use in order to retrieve the contents (Veronesi, 2021, p. 67). A reality that archaeology often encounters, that artifacts are no longer found intact. The fragility of the crucibles, often used once and then discarded, speaks to the experimental nature of the work. The necessity of destroying the crucibles to extract their contents reflects the trial-and-error method common in early scientific practice, where knowledge was gained not just from successes but also from the very act of destroying the tools that contained the results of those experiments.

Crucibles serve as essential artifacts for exploring the intricate processes carried out in early modern laboratories, particularly within alchemical contexts such as the Jamestown colony. Their ability to endure extreme temperatures not only reflects practical functionality but also signals the advanced metallurgical and material knowledge involved in alchemical work. The high alumina clay and specialized firing techniques required for their production point to a sophisticated understanding of materials, aligning with alchemy's complex and experimental nature.

This section underscores why crucibles are significant markers for identifying laboratory activities, thus highlighting their relevance in uncovering the intellectual and material culture that shaped alchemical practices.

5.2. Oberstockstall, Austria



Figur 5: Some of the many artefacts recovered from the laboraotory of Oberstockstall - Martínón-Torres, 2012, p. 33

5.2.1. Introduction

The discovery of the 16th century alchemical laboratory at Oberstockstall, located in Austria, discovered in the 1980s, is a key location in the archaeology of alchemy and early modern chemistry. Its significance lies in the discovery of a remarkably well-preserved and comprehensive set of laboratory tools and materials. The site contains a range of instruments, including furnaces, ceramic crucibles, and glass distillation equipment, which were used in both metallurgical processes like fire assay and in medical alchemy. This discovery provided a unique opportunity to explore the practice of alchemy in its historical and material context, marking an important step in understanding the development of early modern scientific practices (Veronesi, 2023b, pp. 339–340).

The artifacts were uncovered in a dump beneath the sacristy of a church adjacent to a manor house in Kirchberg am Wagram, Lower Austria, likely buried following an earthquake. The collection consists of fragments from around 800 items, including triangular crucibles, shallow scorifiers, bone-ash cupels, alembics, aludels, cucurbits, adopters, receivers, and other chemical apparatus made of

ceramic and glass. Additionally, the find includes metal and slag remnants, furnace bricks, as well as artifacts of leather, textile, and bone (Martín-Torres et al., 2003). In other words, an archaeological dream. This is precisely why I have chosen this site as the second focus for this case, as it offers the opportunity to examine a larger collection of artifacts gathered in one location, within a unified context, which will further aid in exploring the concept of laboratories and what this concept entails.

In this example, the focus will be primarily on the glass finds, in contrast to the crucibles from Jamestown, serving as another indicator of experimental work and knowledge-intensive practices.

5.2.2. History of glass

Glass production, though sharing similar furnace conditions and raw materials with ceramic and metalworking, appears relatively late in the archaeological record, emerging in regions such as Egypt and Mesopotamia around 1600 BCE, later spreading across Europe, India, and China (Rehren, 2024, p. 545). Glassmaking involves two distinct branches, the primary production of glass through the fusion of raw materials, and the subsequent working of glass to create finished objects through manipulation or blowing. Initially, glass was used for decorative purposes, imitating precious stones, but its functional use as containers and vessels began to emerge in more recent times (Rehren, 2024, p. 545). The raw materials for glass include silica (sand or quartz), alkali fluxes (like soda or potash), and stabilizers such as lime, which help reduce the melting point and increase stability. Additionally, metal oxides are added to create various colors (Rehren, 2024, p. 545). This process facilitated the creation of transparent glass and led to the spread of glass working workshops. The distribution of glass items, especially beads, shows how glass traveled far beyond its production areas, reaching distant regions through trade networks (Rehren, 2024, p. 545).

The scientific study of glass however emerged much later than its production. Initially used for jewelry and later for containers and lenses, early glass remained poorly understood due to difficulties in achieving uniform quality (Vogel, 1994). Progress started around 1800 when methods were developed to study glass composition and light refraction, laying the foundation for optics. Inventions such as the spectrometer enabled systematic research, while advancements in glass chemistry introduced new elements such as using crucibles made of platinum instead to prevent contamination (Vogel, 1994). These early experiments furthermore revealing how elements like boric and phosphoric acids could alter glass properties, making the glass more resistance to thermal shock, improved optical clarity and better chemical stability, paving the way for future advancements in

glass science and technology, discoveries that helped improve glass-making techniques and led to new types of glass used in modern technology (Vogel, 1994).

5.3.3. The glass at Oberstockstall



Figur 6: Glass apparatus and fragments from Oberstockstall, displayed at the Alchemistenmuseum in Kirchberg am Wagram – Veronesi, 2023, p. 345

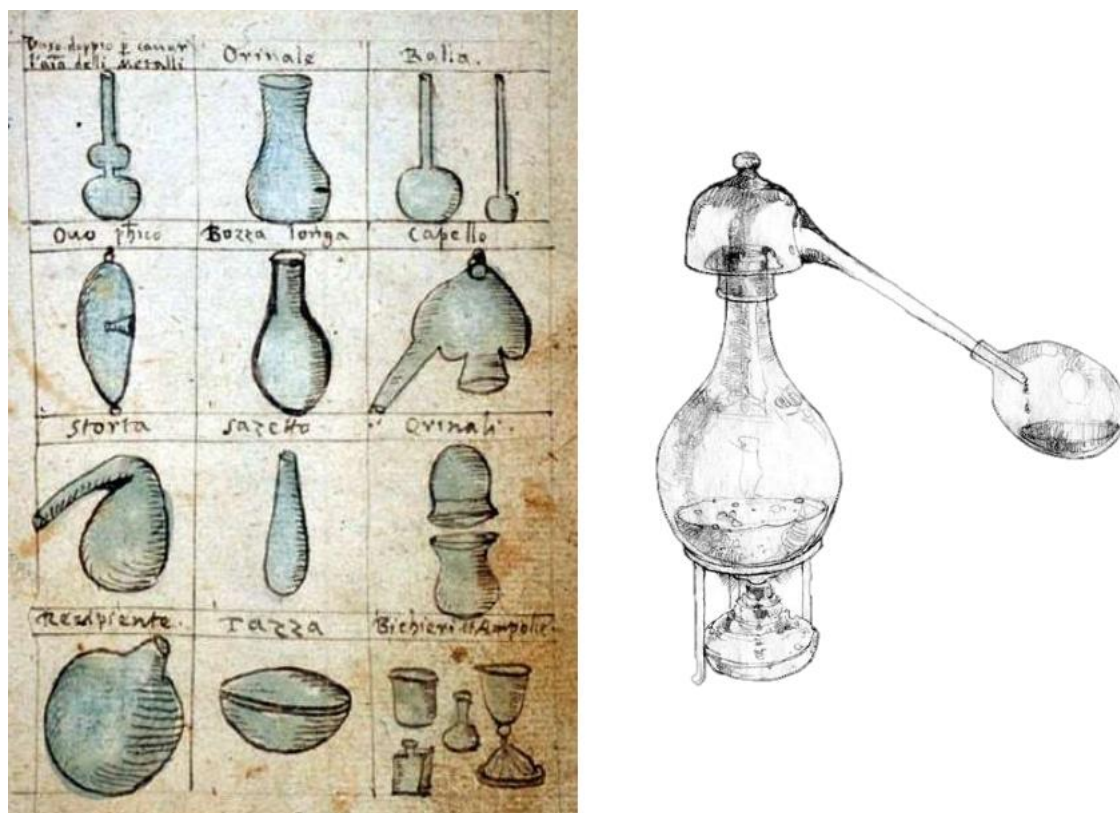
In an archaeological context, glass holds unique value as a material closely tied to alchemical practices. Glass could be molded into nearly any shape or color. Glass was essential for creating distillation vessels and other equipment crucial for alchemical experiments (Veronesi, 2023a). Examining glassware fragments from alchemical sites, such as Oberstockstall, has revealed significant insights into the sourcing and quality of materials essential for early chemical practices. In the case of Oberstockstall, analysis of glass fragments, including specialized distillation vessels and more general-use containers, offers a window into the alchemists choices and priorities in their laboratory setups (Veronesi, 2021, 2023a). Despite glass being a significant focus within

archaeometric research, the study of glass apparatus specifically related to chymistry has received almost no attention (Veronesi, 2021, p. 71).

Research has found distinct chemical compositions indicate two main glass-making traditions in post-Medieval Europe. In central and northwestern regions, glass was typically produced from forest plant ashes, resulting in a potassium-rich, dark-colored glass. Conversely, Venetian glass, made with coastal plant ashes high in sodium, was renowned for its clarity due to careful ingredient refinement (Veronesi, 2023a, p. 98). Analysis of Oberstockstall's glass fragments reveals that alchemists specifically selected high-quality, Venetian or Venetian-style glass for distillation vessels, likely due to its clarity and durability under gentle heating (Veronesi, 2023a, p. 99). This clarity would have been especially valuable, allowing alchemists to observe subtle changes in the substances color or texture during distillation. In contrast, for non-specialized containers, locally made, cost-effective glass with lower clarity was preferred. This distinction highlights how technical considerations directly influenced material selection and shows that these choices were strategically made to optimize the laboratory's effectiveness (Veronesi, 2023a, p. 99).

Venetian glass was thought to be widely exported, though excavations have shown inconsistent distribution across Europe. Recent finds in Great Britain, Slovenia, and even the Caucasus have provided new insights into the reach and techniques of Renaissance glass production (Barbe & Baumgartner, 2021). Twentieth-century studies considered Renaissance Venetian glass mostly authentic, but recent research, spurred by the 2000 Rothschild collection auction, revealed many pieces were 19th-century fakes. This has led to the integration of scientific analysis with art history to authenticate Venetian glass (Barbe & Baumgartner, 2021). For archaeologists investigating alchemical experiments, identifying genuine Venetian glass is challenging, even with chemical methods. Accurate identification now depends on both chemical analysis and historical context, making it crucial to carefully differentiate between authentic glass, imitations, and later copies to avoid misattributions.

5.2.4. Distillation



Figur 7: Examples of glass distillation vessels - Veronesi, 2021, p. 71

Glass was the preferred material for distilling medicine, perfume, alcohol, and other chemical experiments, precisely because of its ability to allow observation and monitoring of the process as it occurred (Veronesi, 2021; Veronesi & Martín-Torres, 2018). A major challenge with glass as an archaeological source is its low likelihood of survival, especially in complete form. Glass artifacts are rarely found intact and are instead often broken into numerous fragments. This makes it difficult to reconstruct the appearance of original apparatus (see figure 7) and highlights the essential role of scientific analysis in studying these materials. Glass distillation vessels typically lack the residue layers like the ones found in crucibles, though the distilled substances can sometimes leave deposits on the vessel's surface (see figure 9) (Veronesi, 2021, p. 72).

Distillation uses much gentler heat than crucible operations, staying well below the melting point of glass, which prevents interaction with the materials inside (Veronesi, 2021, p. 72). This brings me back to the issue addressed earlier in the paper (see 3.1.), about how the archaeological material is limited by its availability, making natural scientific analyses more challenging. The relevance of

typology, based on factors like color and size, to the Oberstockstall glass lies in how it helps archaeologists identify and categorize the fragments. By analyzing attributes such as thickness and clarity, researchers can determine whether the glassware was intended for distillation or general use. This method aids in distinguishing specialized alchemical equipment from more standard containers, providing valuable insights into the choices and priorities of the alchemists who used them, the glass from Oberstockstall showing examples of both the clear Venetian and the more standard glass (Veronesi, 2021; Veronesi & Martínón-Torres, 2018).



Figur 8: Large triangular crucible, with visible residue, possibly from glass making - Veronesi, 2021, p. 142



Figur 9: Reddish deposit left on glass vessels from Oberstockstall - Veronesi, 2021, p. 73

The study of glass fragments from alchemical sites, such as Oberstockstall, offers significant insight into the practical and symbolic aspects since the vessels generally were not only shaped based on practical properties, but often also carried social and more esoteric symbolisms in their design. Examples include being shaped after a women's wombs, the uterus, a bear, intercourse, and more (see figure 10) (Fabricius, 1989, p. 11).



Figur 10: A few examples of symbolic shapes of vessels - Fabricius, 1989, p. 11

5.2.5. What constitutes a alchemist laboratory?

The concept of what defines a laboratory is complex and not easily confined to a single definition. While Oberstockstall offers an example of a well-equipped laboratory, smaller, specialized spaces can also serve the same purpose. The key to understanding a laboratory lies in its practices, particularly the systematic use of tools for experimentation, rather than its size or the variety of equipment. This shift in focus allows for a broader and more nuanced definition, one that considers the specific needs and practices of those using the space, a topic that will be explored further later in this thesis.

Archaeologists seeking to identify alchemical laboratories should focus on finding specific materials, tools, and contextual evidence related to early modern experimentation. Key indicators could include crucibles, such as the advanced Hessian types found at Jamestown, as well as glassware fragments, particularly those linked to distillation activities, like the clear venetian style. Additionally, locating these items within designated spaces, like the "factory" area in Jamestown, or in a context like Oberstockstall, further highlights the presence of specialized, experimental work. Analyzing the types of tools and their context could allow archaeologists to identify laboratories even in the absence of fully intact artifacts.

Case II: Alchemical Illustrations

This section of the thesis seeks to investigate how alchemical illustrations serve as a link between cognitive understanding and material culture. By analyzing illustrations, this case examines how visual representations illuminate the practices, technologies, and intellectual frameworks of alchemy. Artifacts such as crucibles and glassware, can be better understood when contextualized with the symbolic and esoteric imagery found in alchemical art. The methodology integrates iconographic and semiotic analysis, artifact analysis, and historiography to uncover how these visual languages reflect and inform the material remains of alchemical practice. In this case, I will focus on a series of figures related to laboratories, as in case 1, however, this time the emphasis will be on how illustrations and symbols can enhance our archaeological understanding of these spaces, their functions, and the people who used them.

6.1. Illustrations of laboratories

6.1.1. Introduction

Renaissance alchemical illustrations employ a rich semiotic structure, incorporating icons, symbols, and indices to convey complex ideas. Drawing on Peirce's semiotic theory, these images often shift towards indexical signs, where they establish a direct connection between the depicted object and the viewer's experience of the physical world (Szulakowska, 2000, pp. 1–3). These images often used symbolic language to protect esoteric knowledge, presenting thoughts interpretable only by those with proper philosophical and practical training. They also functioned as educational aids, depicting stages of alchemical processes such as putrefaction, calcination, and coagulation (Ackooy, 2016, pp. 13–16). These illustrations highlighted the connections between the universe and the earthly realm, with motifs like the sun and moon symbolizing the balance of masculine and feminine principles. Their artistic and cultural significance endured, influencing later artists, philosophers, and scientists by blending mythology, astrology, and theology into captivating visual expressions (Ackooy, 2016; Newman et al., 2009; Szulakowska, 2000)a.



Figure 12: *Spiegel der Kunst und Natur: in Alchymia* by Stephen Michelspacher, 1615 (Fabricius, 1989, p. 9)



Figure 13: *An alchemist*, Hans Weiditz, c.1520 (Fabricius, 1989, p. 6)



Figure 14: *Practica naturae vera* by C. F. von Sabor, 1721 (Fabricius, 1989, p. 8)

6.1.2. What insights can we gain from them?

Figures 11–13 exemplify how illustrations of alchemical laboratories provide distinct perspectives on the practice (Ackooy, 2016; Fabricius, 1989; Principe, 2013). All three images depict laboratory environments featuring key artifacts analyzed in Case 1 - glass vessels, distillation apparatuses, and triangular crucibles. These objects, as previously established, are key indicators of laboratory spaces. However, each image also provides a distinct overall impression of the alchemical environment and practices, offering varied interpretations of how alchemy was conducted and conceptualized.

Figure 11 presents a highly organized and structured laboratory, divided into two clear zones. On the left, an alchemist engages with distillation equipment, commonly referred to as “the wet path,” while on the right, another the alchemist works with fire and heat, associated with “the dry path” (Ackooy, 2016, p. 33; Fabricius, 1989, p. 9). This division of labor reflects a clear methodological approach to alchemy, emphasizing order and precision. This organized depiction contrasts sharply with Figure 12, which portrays a chaotic and cluttered laboratory. Here, no clear separation of processes is visible, and the disorder suggests a different, perhaps more accessible or informal, form of alchemy. (Fabricius, 1989, p. 6). Notably, the alchemists fine clothing in figure 11 further suggests professionalism and possibly an elite status, indicating that alchemical practice in this depiction was associated with wealth or academic prestige, while those in Figure 12 wear tattered and worn garments, raising questions about the social and economic status of practitioners—an issue that will be explored later in the thesis discussion. This theoretical approach emphasizes the agency of materials, suggesting that objects influence social practices and cognitive processes, rather than being seen as passive (Bille & Sørensen, 2019; Johnson, 2020). In the context of alchemy, objects can be viewed as carriers of history, embodying a biography that links materials to the people who used them (Gosden & Marshall, 1999).

Figure 13, meanwhile, shares similarities with the structured portrayal in figure 11, but stands out due to its obvious symbolic elements. These symbols provide insights not only into the objects depicted but also into the alchemist's role, identity and thought. Above the alchemist, the sun and moon are prominently displayed, representing gold and silver—two of the most significant metals in alchemical practice (Daisy, 2020; L. M. Principe, 2013). These symbols elevate the depicted laboratory from a mere site of experimentation to a space instilled with spiritual significance.

For the archaeologist, perhaps the most noteworthy feature in figure 13 is the presence of five objects adorned with symbolic motifs, suggesting deeper layers of meaning and function within the laboratory. These symbols offer valuable clues for understanding the interplay between the material culture of alchemy and its intellectual and spiritual dimensions. Here, we have a unique opportunity to observe examples of how these objects were likely used by examining the associated symbols (see Figure 14 and 15).

Explanation of the Chymical Characters

p. 491

Steele iron or mars	♂	celestial signe	♂
Loadstone	♂	Cancer	♂
Ayre	♂	another	69
Lymbeck	W	Ashes	E
Allom	○ □	Pot Ashes	⚭
Amalgama	■ ■ ■ ■ ■	Calx	C
Antimony	◇ ♂	quick lime	♀
Aquarius a signe of the zodiack	≈	Cinnabar or	♂
Silver or Luna	☾	vermilion	⚡ ♂
Quicksilver or	♂	Waxe	⚭
Mercury	♀	Crucible	⚡ ▽ ▽
Aries another	♂	Calcinated copper	♂
celestial signe	♂	æs ustū or crocus	♂
Arsenick	○ ○ ♂	veneris	♂ ♀
Balneum	B	♂ ♀ ♀	♂ ♀ ♀
Balneum	-	Note of Distillation	⚭
Maris	MB	Water	≈ ▽
Vaporous	-	Aqua fortis	▽
Bath	VB	aqua Regalis	VR VR
Libra another	♂	Spirit	— ♂
celestial signe	≈	SP.	—
Borax	⚡	Spirit of Wyn	▽ ◇ ◇
Bricks	■	Tinne or Jupiter	♂
capricornus another	♂	Powder of Bricks	■
		Fire	△

Gumme	♂	Crocus	♂
Howe	♂	martis	♂
Oyle	⚡ ○ ○ ♂	Sagitar ^a a celestial signe	♂
Day	♂	Soap	◇
Gemini a celestial signe	♂	Scorpi ^a a Celestial signe	♂
Leo another signe	♂	Salt alkali	⚡ ♂
Stratū sup Stratū or lay upon lay	SSS SSS	Armoniac Salt	⚡
Marcassite	⚡	Comon Salt	⊖ ⊕ ♂
Precipitate of Quickfil ^a	♂ ♀	Salgemme	◇ ⚡ ♂
Sublimate	♂ ♀	Brimst ^a or sulph ^a	⚡ ♂
Moneth	⊠	Black sulphur	⊕
Niter or Salt peter	⊖	Philosophers sulphur	⚡
Night	♀	To sublimate	≈ ○
Gold or Sol	☉	Talc	X
Auripigmentū	⊖	Tartar	⚡ ♂
Lead or Saturne	♂	Taur ^a a Celestial signe	♂
Pisces a Celestial signe	♂	Earth	⚡
Powder	♂	Caput Mortuū	⊕
To precipitate	⚡	Tuty	⚡
To purify	⊖	Glaße	⚡
Quintessency	QE	Vert de grace, or flower of Copper	⊕
Realgar	♂ ♂ ♂	Vinegar	X
Retorte	⚡	Distilled Vinegar	⚡
Sand	⚡	Vitriol	⊕
		Urine	□

Figure 15: Explanation of the Chymical Characters from Nicaise Le Febvre, *A compleat body of chymistry*, London, 1670. (Newman et al., 2009)

A Table of Chymicall & Philosophicall Characters w th their significations as they are usually found in Chymicall Authors both printed & manuscript							
Saturne Lead			Balneu Menie Balneu Vaporis Bene Borax	MB V bn W	Mensis Maur: p ^{er} petet Merc: Saturn Mer: Sublimat		
Jupiter Tinne			Calcare Calx Calx vive Calx ovorum	C W E T W T W	Nota bene Nox	NB P P P	
Mars Iron			Caput mortu Cementore Cera	 		Precipitare Pulvis Pulvis Lateu Purificare Putreficare	
Sol Gould			Christallum Cinis Cineros clavellati Cinalar	 		Quinta Essentia	Q E
Venus Copper			Congulatio Cohobatio Crocus Martis Crocus Verum Es Vstum	 		Realgar Regulus Retorta	
Mercury Quicksilver			Crucibulum Cucurbitum	 		Sal comune Sal Alkali Sal Armoniac Sal Gemme Sal petra Supr Spiritus Spiritus Vini	
Luna Silver			Dies Digerere Dissolvere Distillar	 		Stratisupstrat Solvere Sublimare Sulphur Sulphur vive Sulphur Philosophoru Sulphur nigru	
Acetum Acetudistillat Es Er Alembicus Alumen Amalgama Ammis Antirionum Aqua Aqua Fortis Aqua Regis Aqua Vita Arena Arsenicum Arruncatu Aues chalc Aues pyrom	 	 	Filturc Fumus Equi Furue Flegma Fluore	 	Gumma Hora Igms Igms rota Lapis calaminaru Lapis Lutare Lutum Sapientia	Tartar Calx tartan Sal tartan Tolcum Terra Tigillum Tuna	
Lapis Lapis lazuli Lapis lazuli Lapis lazuli	 	 	Magnes Marchsita Materia Matrimoniu	 	Vitriolum Vitrum Vini de avis Vrina Johannes	 	

Figure 16: Basil Valentine, The Last Will and Testament of Basil Valentine, 1671. (Newman et al., 2009)

Here, we have a unique opportunity to observe examples of how these objects were likely used by examining the associated symbols (see Figure 4 and 5).

Starting with the three presumed glass vessels on the right, we can identify three distinct motifs: ☉ (the alchemical symbol for gold or Sulphur), ☾ (the alchemical symbol for silver or mercury), and a third symbol that is difficult to interpret but might represent another metal or some other mineral based on the two others (Daisy, 2020; Newman et al., 2009). On the left we see the symbol with the triangle above the cross, which is the symbol for sulphur, together with the symbol of a circle with a line through it, which in alchemy is the symbol for salt, as well as the previously unidentified symbol (Newman et al., 2009). Alchemical texts use metals and their transmutation as metaphors for spiritual purification. As an example, the process of turning lead into gold symbolizes the soul's return to its original, virtuous state (Dardagan, 2017). By aligning symbolic motifs with specific tools, these illustrations provide archaeologists with a framework for interpreting artifacts within their alchemical context. These symbols further reinforce the interpretation of the objects as integral to alchemical processes, emphasizing the dual role of tools as both practical instruments and conveyors of symbolic meaning. This interplay between function and symbolism underscores the interdisciplinary nature of alchemical practice

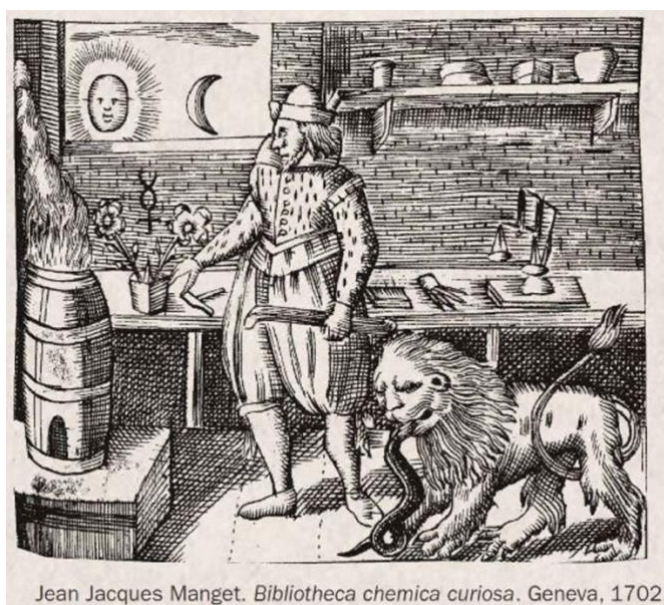


Figure 17: (Daisy, 2020)

Figure 16 (Daisy, 2020) encapsulates many of the themes discussed, featuring familiar alchemical symbols such as the sun, moon, and mercury alongside more unique elements. The symbol ☿ is visible, representing mercury (or quicksilver) in alchemy (see Figures 4 and 5). Notably, flowers can be seen blooming from the crucible, possibly symbolizing beauty, growth, and the completion of fermentation, a key stage in the alchemical process leading to the attainment of the philosopher's stone (Daisy, 2020).

The figure also depicts a lion with a snake in its mouth, a motif rich in symbolic meaning. This is interpreted as representing the unity and struggle of opposites: one body absorbs another distinct entity and transforms it, making it alike (Rodyhin & Rodyhin, 2020). Alchemy often revolves around the unification of dualities, for example, the masculine and the feminine, the spiritual and the material, or the sun and the moon, which, through a process of transformation, are integrated into a higher unity. This can also be seen as a metaphor for transmutation: the process in which imperfect materials are combined and refined through struggle and union to become something noble and perfected (such as gold). It may also refer to the inner alchemical journey, where opposites within the human soul or spirit are reconciled to achieve spiritual enlightenment or the philosopher's stone (Fabricius, 1989; L. M. Principe, 2013).

Alchemy operates as a deeply symbolic discipline, integrating natural philosophy, cosmology, and mysticism into its framework. Central to alchemical thought are the four classical elements, fire, water, earth, and air, arranged in a conceptual circle (Dardagan, 2017). These elements are interconnected by shared qualities, as an example linking heat to fire and air. Surrounding this system are connections to the seasons, human emotions, and the balance of body and soul, all tied to alchemy's goal of understanding the unity of the universe (Dardagan, 2017; Fabricius, 1989). Alchemy also describes spiritual growth through four key stages: Nigredo (blackening), Albedo (whitening), Citrinitas (yellowing) and Rubedo (reddening) (Dardagan, 2017; Fabricius, 1989; Hamilton, 1985). These phases symbolize breaking down the old, purifying the soul, and achieving unity with the divine. The knowledge of alchemical symbols like the Alchemical Egg, Tree of Life, and Peacock's Tail can enrich our understanding of archaeological artifacts by linking them to deeper processes of creation, transformation, and completion. The Alchemical Egg represents potential and new beginnings, the Tree of Life symbolizes growth and interconnectedness, and the Peacock's Tail marks the final flourishing of transformation. Recognizing these symbols in relation

to artifacts, allows archaeologists to interpret them not just as functional objects, but as representations of cultural beliefs (Dardagan, 2017; Fabricius, 1989), the appropriate approach to avoid allowing our own interpretations to shape how we tell the stories of ancient artifacts. Instead, we should seek to understand these objects through the stories they embody, often conveyed through these symbols. This way, we can interpret the artifacts not just as physical objects, but as representations of the cultural and philosophical narratives that were central to their creators worldview. Although the alchemical stages may not immediately seem necessary for understanding the function of archaeological artifacts, as highlighted throughout the thesis, it is equally important to comprehend the stories and background behind actions, as much as understanding their practical use.

In examining alchemical illustrations as a tool for archaeological interpretation, it becomes evident that these visual representations offer rich insights into both the material and symbolic dimensions of alchemy. The interplay between practical artifacts, like crucibles and glassware, and the symbolic language of alchemical illustrations suggests that objects were not merely functional, but also carriers of deeper philosophical and spiritual meanings. The illustrations provide a unique lens through which we can understand alchemy not just as a physical practice, but as an intellectual and esoteric pursuit, linking the material culture of the time with broader metaphysical ideas. This perspective invites further discussion on how alchemical symbols and their associated artifacts can enhance our archaeological interpretations, offering a more holistic view of ancient alchemical practices. Therefore, while we have only begun to scratch the surface of this complex relationship, it sets the stage for deeper exploration into the intersection of material culture, symbolism, and the intellectual landscapes of alchemy.

Case III: Danish alchemy

Understanding alchemy in early modern Denmark requires examining its intersection with science, medicine, and material culture. Tycho Brahe's laboratory at Uranienborg offers a compelling case, blending astronomical research with Paracelsian alchemical practices focused on healing and metallurgy. The discovery of crucibles at sites like Kvæsthusbroen and Amalienborg, containing traces of gold, silver, mercury, and zinc, further highlights the spread of alchemical techniques in Denmark. The Hessian crucibles, imported from Germany, illustrate the trans-European exchange of knowledge and tools, revealing Denmark's integration into broader alchemical networks. Additionally, the Bjørnkær distillation set, with its uncertain purpose, suggests the multifaceted nature of alchemical experimentation, encompassing both practical and esoteric aims.

The goal of this study is to explore how these artifacts, ranging from crucibles to distillation equipment, can shed light on Denmark's role in early modern alchemy. By analyzing their material, context, and connections to European traditions, this research aims to deepen our understanding of alchemy's scientific, medicinal, and symbolic significance in Denmark.

7.1. Tycho Brahe – Denmark's alchemical astronomer

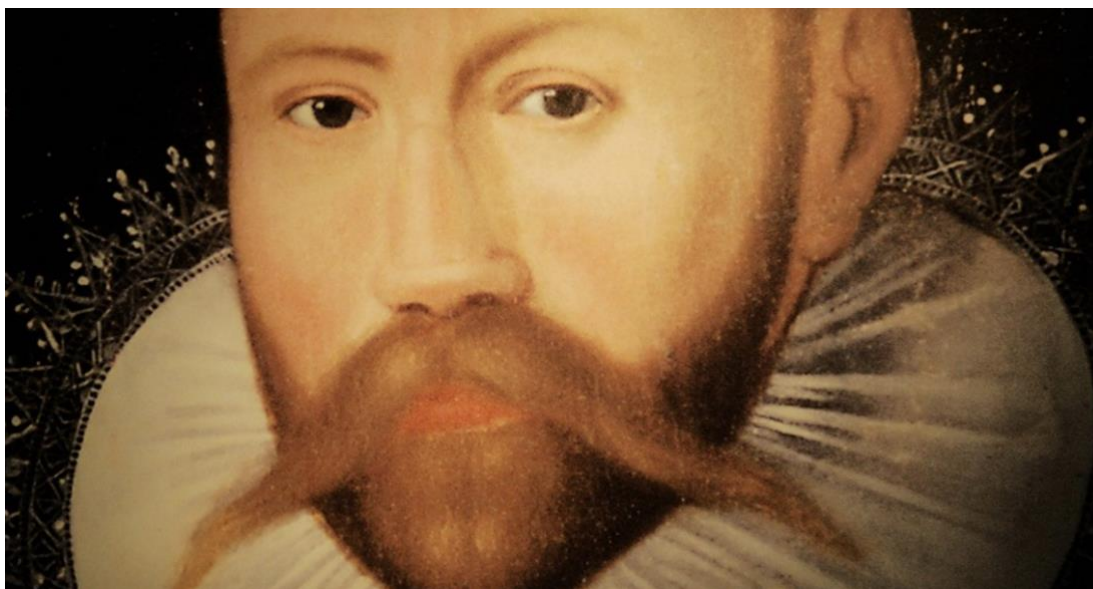


Figure 87: Tycho Brahe.(Kristensen, 2016)

7.1.1. Introduction

As previously established, alchemy encompasses various disciplines, including astrology. Tycho Brahe (1546-1601) is likely best known as the renowned astronomer who paved the way for modern

astronomy with his observations (Christianson, 2002; Rasmussen & Grinder-Hansen, 2024). Tycho Brahe's contributions to early modern science are most often associated with his groundbreaking astronomical observations. However, his alchemical endeavors at Uranienborg, his estate on the island of Ven, offer a fascinating glimpse into a Renaissance worldview where science and alchemy were deeply interconnected. Built in the 1580s, Uraniborg housed not only observatories but also an elaborate alchemical laboratory (Christianson, 2002; Rasmussen & Grinder-Hansen, 2024).

Tycho Brahe left Denmark for Prague in 1599 due to growing tensions with King Christian IV and financial difficulties. After the death of his patron, King Frederick II, Tycho's support waned, and he faced political challenges, particularly after the Danish crown took control of his observatories on Hven. In Prague, Tycho found a new patron in Emperor Rudolf II, who offered him the position of imperial astronomer, providing the resources and freedom to continue his astronomical work. This move allowed Tycho to escape his troubles in Denmark and pursue his research under more favorable conditions (Christianson, 2020). Prague has a rich historical association with Alchemy. During the reign of Emperor Rudolf II alchemy was a significant cultural and intellectual phenomenon. Rudolf, known for his patronage of the arts and sciences, fostered a vibrant alchemical community at his court. Rudolf II attracted many prominent alchemists, astrologers, and scientists to his court in Prague, hoping to uncover the secrets of transmutation and other alchemical pursuits. (Purš & Karpenko, 2016).

7.1.2. Uranienborgs alchemical laboratory

Brahe's laboratory was situated in the basement of Uranienborg, with 16 specialized ovens designed for a variety of processes. Later additions included five more ovens in the living quarters, reflecting the importance of convenience and continuous experimentation. Descriptions by visitors highlight the lab's extensive collection of furnaces, glassware, and distillation equipment, underscoring Brahe's significant investment in alchemical research (Rasmussen & Grinder-Hansen, 2024). Brahe's interest in alchemy was not focused on the common pursuit of turning base metals into gold. Instead, he concentrated on spagyric medicine, inspired by Paracelsus, which sought to extract healing essences from natural substances. His holistic approach integrated cosmic influences with earthly materials, reflecting the Renaissance belief in the microcosm-macrocosm analogy, where the human body mirrored the universe (Rasmussen & Grinder-Hansen, 2024; Svennevig, 2024).

Brahe's alchemical philosophy, inspired by texts like the *Emerald Tablet*, a short cryptic text outlining the principles of alchemy and the transformation of substances (Principe, 2013), emphasized the unity between the heavens and Earth (Rasmussen & Grinder-Hansen, 2024). At Uraniborg, symbols of this harmony reinforced his belief that studying the cosmos and experimenting with earthly elements were interconnected. While open about his astronomical discoveries, Brahe kept his alchemical work secret, sharing it only with trusted associates. His rejection of gold-making as futile reflected his focus on practical applications, especially in medicine (Rasmussen & Grinder-Hansen, 2024).

Archaeological excavations at Uraniborg, beginning in 1824 and continuing in the late 20th century, uncovered valuable artifacts that shed light on Brahe's alchemical activities. The remains of ovens, fragments of glassware, and ceramic vessels were discovered, many bearing traces of ash, charcoal, and chemical residues (Rasmussen & Grinder-Hansen, 2024). These artifacts provide a rare window into the laboratory processes employed by Brahe and his team. Advanced analytical techniques revealed the presence of various elements on the shards, including calcium, wolfram, tin, lead, and gold. The discovery of wolfram, a metal formally identified centuries later, suggests its accidental incorporation through naturally occurring minerals (Rasmussen & Grinder-Hansen, 2024). The analysis of shards from Uraniborg's lab indicates the presence of gold, mercury, and copper, elements associated with Paracelsian medicine, which is an approach that combines philosophy, chemistry, and medicine, focusing on the idea that human health can be understood and treated through both spiritual and material processes. It emphasizes the use of alchemical substances rather than traditional remedies, aiming to heal by stimulating the body's natural processes (Hedesan, 2014; Rasmussen & Grinder-Hansen, 2024). Gold, for instance, was believed to possess restorative qualities, while mercury was used in treatments for infections and skin conditions (Newman et al., 2009; Rasmussen & Grinder-Hansen, 2024). However, the discovery of the elements lead, nickel, and wolfram, which have no known medicinal use, indicates that Brahe also engaged in metallurgy.

7.1.3. Further proof

In recent studies by a team of Danish/Czech researchers, Tycho Brahe has been linked to the use of gold and other metals through recent scientific analyses of his remains. Tests on his hair revealed elevated levels of gold, 20 to 100 times higher than normal, suggesting regular exposure, possibly through gold-plated objects, elixirs, or alchemical practices (Kristensen, 2016). The period leading

up to Tycho Brahe's death remains shrouded in mystery and speculation, particularly regarding the cause of his sudden illness and subsequent death in 1601 (A. K. L. Rasmussen, 2017). Despite long-standing theories, new studies have ruled out poisoning by mercury, dismissing the widely accepted cause of his death. These findings open new questions about his final months, marking a shift from acute poisoning to potential lifestyle or experimental factors contributing to his death (Kristensen, 2016). The results also revealed a significant shift in his diet or medical treatment roughly two months before his death, suggesting that some drastic change occurred during this time. This finding challenges the longstanding narrative of a sudden illness and supports the hypothesis that Brahe's death was preceded by a more gradual deterioration, potentially linked to his exposure to alchemy or chemical experimentation (A. K. L. Rasmussen, 2017)

Tycho Brahe's alchemical work in Denmark, particularly at Uranienborg, reveals a fascinating intersection of science, medicine, and spirituality. His approach to alchemy was deeply influenced by Paracelsian ideas, focusing on the practical application of alchemical substances for healing rather than the pursuit of gold. The discovery of various elements in his laboratory artifacts, along with recent studies of his remains, suggests that Brahe engaged in both medicinal and metallurgical experiments. This blend of alchemical and astronomical pursuits reflects the Renaissance belief, offering a unique perspective on early modern science in Denmark.

7.2. Crucibles from Kvæsthusbroen

In 2010, archaeologist Susanne Møller Johansen wrote a thesis specifically about crucibles from the Kvæsthusbroen in Copenhagen (Johansen, 2010). Kvæsthusbroen, located in Copenhagen, was built in the mid-19th century as part of the expansion of the city's harbor area. The area around the bridge was once open water, with the medieval coastline running along what is now Amaliegade. The landfill started in the early 1700s, and significant expansions of the bridge occurred in 1876, 1938-39, and 1968-77. Originally, the area was home to the military hospital, Kvæsthuset, built in 1684, which later served as a warehouse and barracks. The first bridge was built in 1849-50, extending the quay, and was expanded several times over the years to accommodate growing maritime traffic. By the early 1900s, the area saw bustling shipping activity, with daily routes to various Danish and Swedish ports. However, the expansion of air, rail, and road transport in the mid-20th century reduced the role

of shipping. Today, Kvæsthusbroen is no longer a busy port but is part of the cultural transformation of the area, particularly with the construction of the Skuespilhus (Johansen, 2010).

During the archaeological excavation, approximately 800 items were recovered. The finds were diverse, including pottery, stoneware, glass, faience, majolica, albarelli, stone pipes, porcelain, tiles, glass bottles, wine balloons, crucibles, metal objects, bones, oyster shells, charcoal, slag, stone tools, as well as textiles, wood, and leather items (Johansen, 2010). Out of all these finds, 56 fragments from crucibles were discovered, all found within a very restricted area, all showcasing a glass like residue (Johansen, 2010).



Figure 18: Crucible from Kvæsthusbroen (Johansen, 2010)

Investigations of the crucibles from Kvæsthusbroen align with the assumptions set in Case 1, specifically that they are made from aluminum and silica-rich clay, tempered with quartz. The crucibles from Kvæsthusbroen are also considered to be of Hessian type (Johansen, 2010; Veronesi, 2021). Based on the area's history and our knowledge of the German-imported crucibles, there is now a valid argument that alchemical specific imports also reached the Danish region, a crucial discovery and piece of knowledge for the focus of this thesis.



Figure 19: Fragment of a crucible with gold particles (Johansen, 2010)

One very important find from the excavation is the fragment with visible gold particles (see Figure 19). Eight of the crucibles were found to have contained gold, nine contained silver, three contained zinc, and two contained mercury (Johansen, 2010; Newman et al., 2009). This aligns closely with the information gathered from Case 2, where the same metals were identified in the illustrations, further supporting the presence of alchemical knowledge and practices in Denmark.

7.2.1. Crucibles from Amalienborg

Furthermore, Johansen, as comparative material for the crucibles from Kvæsthusbroen, discusses a number of crucibles from other Danish locations, including Amalienborg. This is due to the discovery of stamps beneath one of the crucibles, along with the characteristic glass-like surface inside (Johansen, 2010).



Figure 20: Stamp on the bottom of the crucibles, along with a drawing of the same (Johansen, 2010)

(see figure 20) 4 is the alchemical symbol for tin (or the planet Jupiter) (Newman et al., 2009). The stamp is characteristic of crucibles from the German town of Obernzell in Bavaria. Recent studies indicate that a large-scale production of high-quality crucibles took place in the area, with the number "4" serving as their trademark (Johansen, 2010; Martínón-Torres & Rehren, 2009). This further supports the theory of imported alchemical laboratory equipment into Denmark.

Regarding the remaining symbols on the stamp, they have yet to be identified with any direct comparable examples. However, based on a preliminary analysis, it is plausible to suggest that these symbols may represent a formula associated with an experimental process. In alchemical tradition, the letter M is frequently linked to the Virgin Mary, though it may alternatively signify a signature, such as K M (Fabricius, 1989; Newman et al., 2009).

The discovery of crucibles at Kvæsthusbroen offers significant insights into the presence of alchemical practices in Denmark. The presence of crucibles containing traces of gold, silver, zinc and mercury strongly suggests the application of alchemical techniques. The crucibles being the imported German-made Hessian type, reinforces the idea that alchemical knowledge and tools were circulating across Europe. Moreover, the comparison with crucibles from Amalienborg further supports the notion, that alchemical practices were not isolated but interconnected within the broader European context, for example through stamps and symbols.

7.3. The Bjørnkær set



Figure 21: The complete Bjørnkær set (Roesdahl, 2014)

7.3.1. Introduction

Around 1930, a ruin in Odder, the former Bjørnkær fortress, was excavated under the leadership of the National Museum's castle researcher C.M. Smidt and physician and amateur archaeologist Jørgen Didriksen. In fact, most of the work, both during and after the excavation, was carried out by Didriksen (Roesdahl, 2014). Bjørnkær was regarded as an important fortress in the Middle Ages and is said to have been owned by the nobleman Marsk Stig (Bostrup, 1984). The set was discovered discarded in a well, surrounded by the brun grain, likely discarded during a siege, interpreted as an attempt to prevent the technology from falling into enemy hands (Bostrup, 1984). The secrecy and desire to protect knowledge implied in its disposal adds another layer of intrigue to the set's historical significance.

The find consists of a larger set of 35 objects (see figure 21) (Roesdahl, 2014). It is interpreted as a primitive distillation apparatus, likely used for the production of spirits. If this interpretation is correct, it represents the oldest example of such equipment in Danish archaeological material (Johansen, 2010; Roesdahl, 2014). Experimental archaeology studies have since been conducted on the set to further understand how and for what purpose it was used in distillation. Today, the artifacts are divided between the National Museum and Odder Museum, with only a very small part being at the National Museum.

The Bjørnkær set consists entirely of locally produced ceramic items, with no indication of foreign influence in their materials or craftsmanship. The unique design of certain items, such as the funnels, large bowls, lids, and bimbles, suggests they were custom-made for a specific purpose. Dating the set remains challenging due to the lack of parallels for most of the forms. However, based on objects like the globular pot and skillet, and the absence of glazed jugs and jydepotter, the set is tentatively dated to the late 14th century or around 1400. This timeframe aligns with the few historical references to Bjørnkær, which first appears in records in 1427 (Roesdahl, 2014).

7.3.2. A Reconstruction, experimental archaeology

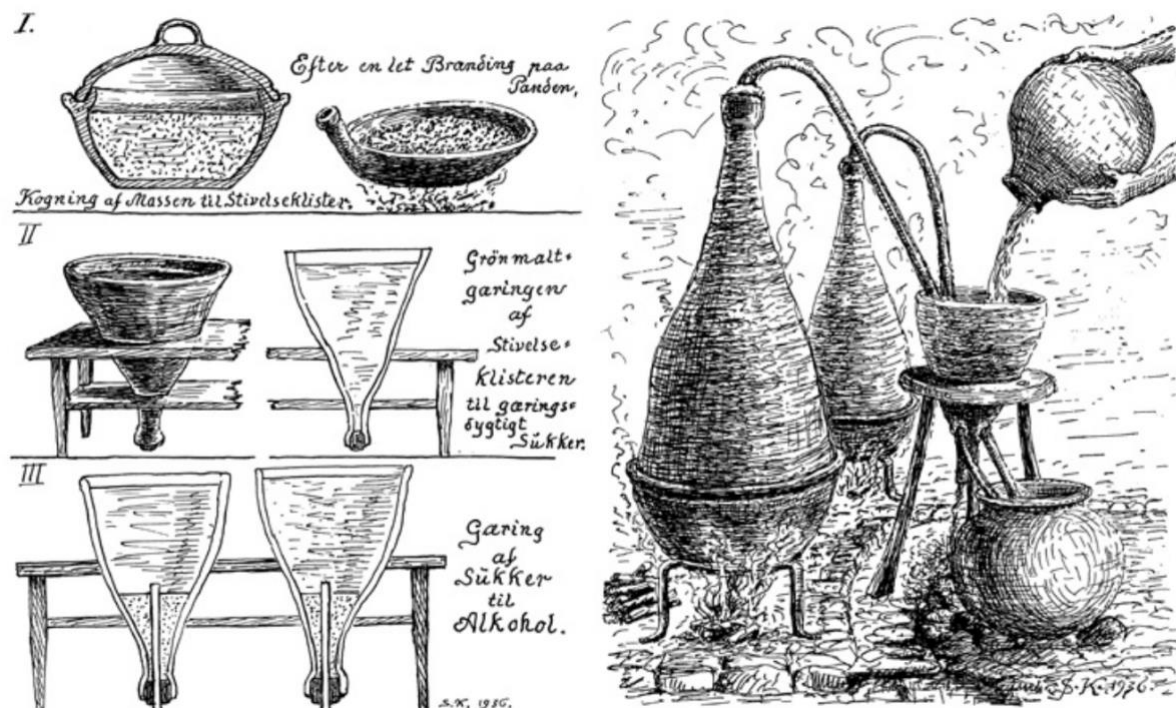
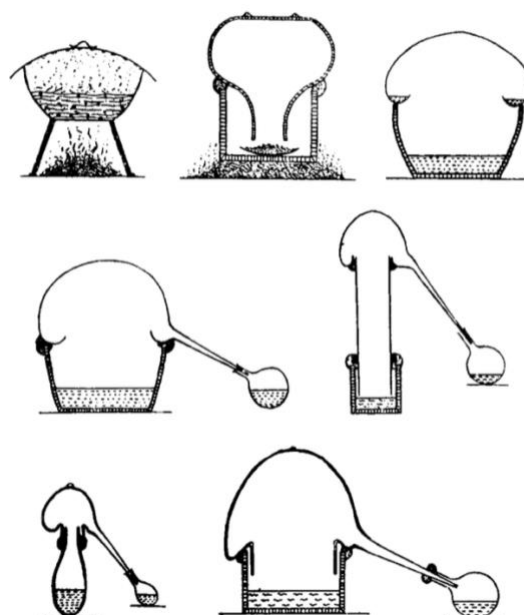
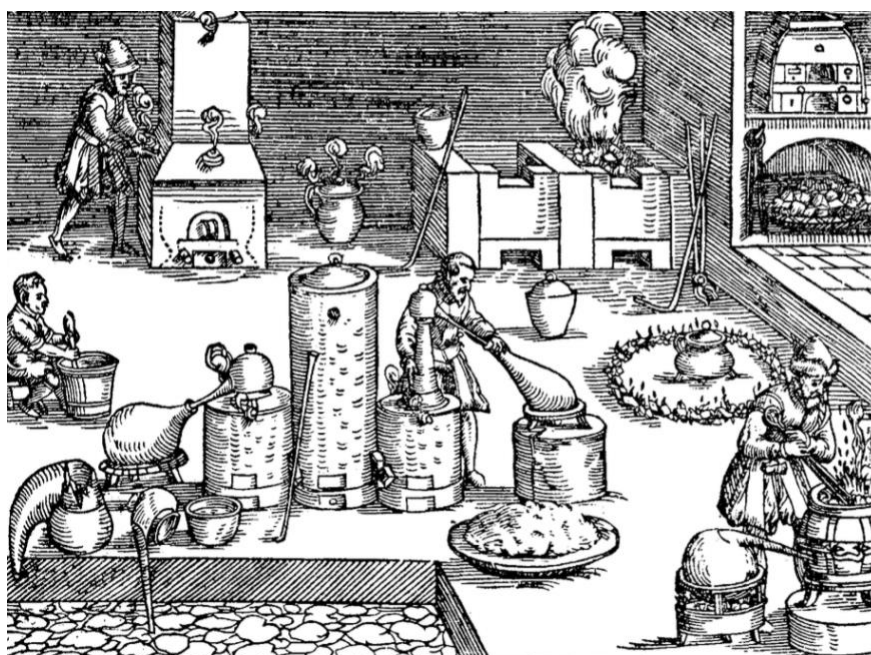


Figure 22: Physician Didriksen's reconstruction of how the Bjørnkær set was used for spirit production. Drawings by Søren Knudsen, 1936, Didriksen, 1941(Roesdahl, 2014)

The reconstruction demonstrated the possibility of producing a distillate with an alcohol content of approximately 60-70%, which can be considered a successful outcome (Johansen, 2010; Roesdahl, 2014). However, this result does not definitively confirm that the purpose was to produce spirits. A counterargument is that only a small portion of the artifacts were found to fit together, which is a critical detail in the distillation process, as ensuring a tight seal between the components is essential (see figure 22 for interpreted setup) (Johansen, 2010).



Figur 23: Evolution of the still, After F. Sherwood Taylor, *Annals of Science*, v (1941-7) (Moorhouse et al., 1972)



Figur 24: Distilling in the 16th century, After L. Ercker, *Treatise on Ores and Assaying* (1574) (Moorhouse et al., 1972)

Didriksen's theory is based on the idea that the set was used for distilling spirits, supported by its discovery alongside grains. He suggests that the process began with roasting the grain, followed by crushing it and adding it to a vat of water. The mixture was then heated until the grain turned into a starchy paste. This paste was then mixed with green malt and left to ferment overnight, transforming



Figur 25: Odder Museum reconstruction of Didriksens setup. (Roesdahl, 2014)

the starch into fermentable sugars. Yeast was then added, and after some time, the mixture became a kind of beer due to the alcohol produced during fermentation. The alcoholic liquid was then transferred to another vessel, where it was heated. The alcohol vapors rose through a funnel and into a lead pipe (fragments of which were also found during excavation), where they would cool and condense into alcohol, which could then be collected and consumed as strong liquor. (Bostrup, 1984).

7.3.3. Scientific analysis of the Bjørnkær set

Subsequent analysis of the organic material found on the Bjørnkær distillation set using C14 dating yielded inconclusive results. As a result, researchers shifted their focus to examining the grain (Jensen & Larsen, 2022). The findings primarily indicated plant material, including charcoal, remnants of grain, and other botanical remains. Additionally, small amounts of lime, daphnia eggs, and clusters of shiny, slag-like organic material were identified. The lime is believed to originate from construction materials, while the daphnia eggs are likely related to the original well fill and not directly connected to the distillation set. The nature and context of the slag-like material remain uncertain (Jensen & Larsen, 2022).

The Bjørnkær distillation set and associated grain finds offer compelling but ambiguous evidence regarding their function, leaving open the possibility of both practical alcohol production and alchemical experimentation. Distillation in medieval Europe had diverse applications, from producing perfumes and medicinal substances to extracting alcohol (Jensen & Larsen, 2022). The set at Bjørnkær, however, lacks conclusive signs of brewing, such as malted grains, which are essential for alcohol production. This absence challenges the theory that the apparatus was used solely for making spirits, despite Didriksen's argument that the charred grain supports this interpretation.

The grain composition primarily features six-rowed barley with minimal oats and rye, typical of medieval Danish agriculture, suggesting general storage rather than a specialized brewing process, while the presence of distillation equipment alongside these grains may reflect incidental disposal rather than direct functional association (Jensen & Larsen, 2022).

Alchemical use, while speculative, remains a possibility. Medieval alchemy often involved experiments with various substances, and the distillation set could have served multiple purposes, aligning with broader alchemical practices. However, without specific residues or documentation, the precise role of the Bjørnkær set remains uncertain. Thus, both practical and esoteric functions are plausible, further evidence is needed to clarify its true purpose.

7.3.4. Distillation – Rickmansworth England

The discovery of 15th-century glass fragments from the 1958 excavation at Rickmansworth England (Jensen & Larsen, 2022), linked to distillation apparatus provides crucial evidence for understanding early alchemical practices. It serves as an excellent point of comparison to help understand the art of distillation, particularly when contrasted with our more limited knowledge of the Bjørnkær set relation to alchemy. These fragments, likely parts of alembics and cucurbits, are among the earliest known examples of distillation equipment found in Europe (Moorhouse et al., 1972). While distillation was central to both alchemical processes and commercial practices, it has not always been recognized in the context of alchemy.

Distillation played a crucial role in early alchemical practices, particularly in pharmaceutical chemistry. Initially, distillation focused on extracting medicinal compounds from plant and animal materials, as seen in texts like Brunschwig's *Kleines Destillierbuch* (c. 1512), which described various distilling techniques and equipment used for this purpose (Lefèvre, 2021). The development of distillation technology is rooted in ancient and medieval knowledge, with significant contributions from both classical texts and Arabic sources, later transmitted to the West. Brunschwig and other authors of the 16th century documented distillation processes that not only had medical applications but also linked alchemical theory to practical experiments (Lefèvre, 2021).

The fragments from Rickmansworth could indicate a wide range of possible contexts. First theory is a glass factory where distillation apparatus was produced, though no other related evidence, such as furnaces or partially worked glass, has been found to support this hypothesis. Alternatively, the alembics may have been used in domestic contexts, possibly for distilling liquors like aqua-vitae or herbal liqueurs, but no organic residues have been identified so far to confirm this. Another plausible explanation is that the apparatus was used for alchemical experiments, as distillation was integral to the alchemical search for transformation (Moorhouse et al., 1972). However, distinguishing residues from these experiments could be challenging given the broad range of substances alchemists worked

with. Finally, the alembics may have been used for distilling substances like nitric acid for metallurgical purposes, such as assaying metals, with residues like calcium and phosphorus suggesting a link to metallurgy. The presence of tin and lead could further point to a connection with metalworking. While some residues, such as bone-ash, are consistent with metallurgical practices, further analysis of the site's metallurgical activities, particularly any found crucibles, is needed to clarify this connection (Moorhouse et al., 1972).

The Bjørnkær distillation set presents an intriguing but inconclusive case for its function, possibly linked to alcohol production or alchemical experiments. While Didriksen's theory supports spirit distillation due to the presence of grain, the absence of malting evidence weakens this claim. Comparisons to early distillation artifacts, like those from Rickmansworth, suggest multiple potential uses, including medicinal and metallurgical purposes. Ultimately, without direct evidence, both practical and esoteric roles remain plausible, requiring further analysis to determine its true significance.

8. Partial conclusion

The analysis of alchemical practices across various sites, has highlighted the intricate interplay between material culture, intellectual pursuits, and experimental techniques in early modern laboratories. Crucibles, such as those found at Jamestown and Kvæsthusbroen, underscore the advanced metallurgical knowledge involved in alchemy. The presence of Hessian crucibles in Denmark, with traces of precious metals, suggests a shared European alchemical network, emphasizing the widespread circulation of specialized tools and knowledge. These artifacts reveal not only practical functions but also deeper philosophical meanings linked to alchemical goals.

Laboratory spaces, exemplified by Oberstockstall and Tycho Brahe's Uranienborg, demonstrate that the defining feature of a laboratory lies in its systematic practices rather than its physical size or diversity of equipment. The fusion of alchemy with astronomy and medicine at Uraniborg reflects a worldview, integrating science and spirituality, particularly through Paracelsian healing methods.

Artifacts like distillation sets, as seen in Bjørnkær and Rickmansworth, further complicate interpretations. The Bjørnkær set, while suggestive of alcohol production, also invites speculation

about its use in alchemical experiments due to its ambiguous evidence and parallels with early distillation equipment. The symbolic dimensions of alchemical illustrations provide a complementary perspective, linking material artifacts to esoteric practices and broader intellectual traditions.

Together, these findings illuminate alchemy's multifaceted nature, blending practical experimentation with metaphysical exploration. This sets the stage for a deeper discussion on how archaeological interpretations can bridge material evidence with symbolic and intellectual contexts, offering a more comprehensive understanding of early modern alchemical practices.

Discussion

9.1. How to: classify a laboratory?

In alchemy, as already established, it is necessary to approach the subject in a comparative way, examining it from the perspectives and methods of multiple disciplines. In the previous section, we have explored various ways to approach the alchemical material, first and foremost with a material approach, focusing on the objects found and their potential uses. We then looked at a historical and iconographic approach, where the focus was on understanding the finds through the context of visual sources and motifs. The intention was to establish a foundation for how the interpretation of these finds can be enriched by understanding them through the eyes of the period. We are situated in the Middle Ages and the Renaissance, and as archaeologists, we have a unique opportunity to contribute to this understanding through these sources. The analysis has primarily centered on laboratories, but we still need to address how, as archaeologists, we can identify an alchemical laboratory in practice. What concrete signs can we use to classify a site as a laboratory?

The concept of the "laboratory" before the 19th century was not defined in the way we understand it today. It referred to spaces where manual, chemical work was carried out, often involving processes such as distillation, metalworking, glassmaking, and pigment production (Hannaway, 1986; Veronesi, 2021). These spaces, which combined both practical and theoretical approaches, were defined by their focus on experimentation, observation, and the high-temperature manipulation of substances. The defining feature of these early laboratories was not just the activities performed, but the specialized equipment used, such as furnaces for smelting and distillation (Martínón-Torres et al., 2003; Veronesi, 2021). However, one of the key points that emerges from this historical examination is that the distinction between the "laboratory" and the "workshop" was far less clear in its definition, than it is in modern discussions. Both spaces were involved in transforming materials, and the same set of practices could occur in either space, depending on the context (Veronesi, 2021).

Historically, scholars have attempted to classify these spaces based on their functions, distinguishing between investigation, production, testing, and teaching. However, the neat separation of these categories does not fully account for the complexities of early modern chymistry (Veronesi, 2021). It oversimplifies the material and social connections that existed between different types of chymical activities. The work done in early chemical spaces was not always so easily divided between a

practical production and a philosophical inquiry (Veronesi, 2021), as this thesis has mentioned a few times, there is a much more fluid transition involved, which both complicates classification and at the same time makes the concept more informative.

The recognition of this interplay between practice and theory calls for a more nuanced approach to studying chymistry. Instead of separating laboratories and workshops, it would be more productive to adopt a material-driven framework. Such an approach would focus on the types of tools and substances used across different spaces, offering a deeper understanding of the operations carried out (Martínón-Torres & Rehren, 2005, 2009; Veronesi, 2021). For example, high-quality crucibles were often imported, as we see in the hessian examples, most likely at significant cost, demonstrating the importance of accuracy in these spaces. On the other hand, in less precision-focused contexts like glassmaking, local materials and equipment were often sufficient, in situations where access to the clear imported glass may not have been available or affordable, though the high-quality crucibles remained important for withstanding the high temperatures of the glassmaking process (Martínón-Torres & Rehren, 2009; Veronesi, 2021).

These material considerations not only highlight the differences in the types of work being done but also suggest connections between different practices that would otherwise remain hidden. For instance, substances like lead were used in various ways across different chymical contexts, whether in glassmaking, where it was used for both structural and aesthetic purposes, or in fire assays, where it functioned as a collector for noble metals (Bayley et al., 2001; Veronesi, 2021). By focusing on the materials and tools, we can see that these different spaces, whether focused on commercial production or scientific investigation, were interconnected in ways that challenge traditional categorical distinctions (Veronesi, 2021).

Ultimately, a material-driven approach allows for a more dynamic and fluid classification of early chymical spaces. It encourages us to look at how materials crossed boundaries and how different practitioners, from craftsmen to natural philosophers, were engaged in overlapping practices. The traditional division between the "workshop" and the "laboratory" is useful to some extent, but it limits our understanding of the rich, interconnected world of early modern chymistry. By examining the materials and tools used across different contexts, we have chance to create a more comprehensive

picture of early chemical work, one that moves beyond simplistic distinctions and acknowledges the complex relationships between theory, practice, and materials.

Classifying a site as an alchemical laboratory requires an integrative approach that combines archaeological evidence, historical context, and material culture. By focusing on the tools, materials, and spatial organization, archaeologists can reveal the nuanced and interconnected practices of early modern chemistry, moving beyond simplistic definitions and modern beliefs, and capturing the full complexity of these experimental spaces as a more fluid place, just like alchemy itself.

9.2. Symbolic interpretations of artifacts

Building on the previous discussions about material evidence, it is now relevant to delve a bit more into the visual sources and the role of these alchemical symbols. Symbols such as the ouroboros, the philosopher's stone, and various planetary and astrological elements offer more than just visual appeal, they provide insight into the metaphysical framework underpinning alchemy, as the examples from case 2 with the various symbols on the materials. These symbols were not merely ornamental but served as coded representations of complex concepts (Ackooy, 2016; Fabricius, 1989; L. M. Principe, 2013).

An argument for why we as archaeologists should include symbols in our investigations, such as the sun and the moon, is because it provides valuable insight into the mindset of practitioners. Their presence suggests that alchemists saw their work as a fusion of material experimentation and spiritual transformation. These symbols often convey metaphysical ideas, such as the we learned through figure 8 in case 2 (Fabricius, 1989; Newman et al., 2009), which can help archaeologists interpret the broader philosophical goals behind alchemical experiments.

However, interpreting symbols also carries risks. Many motifs, like the ouroboros, appear across different cultural contexts, not exclusively linked to alchemy (Reemes, 2015). This raises the possibility of misattributing spiritual meaning to objects without sufficient evidence. To avoid speculation, archaeologists should prioritize corroborating symbolic interpretations with material data. This would ensure a more grounded understanding of the artifacts' roles in alchemical practices.

In medieval alchemical texts, visual elements, including diagrams and figurative representations, helped bridge the gap between observable processes and hidden esoteric concepts (Obrist, 2003). However, interpreting such symbols archaeologically requires caution. While they can reveal alchemical intentions and worldviews, these motifs also had broader cultural significance, risking misinterpretation without corroborating material evidence. Thus, symbols should complement, not replace, empirical analysis of artifacts (Obrist, 2003; L. M. Principe, 2013).

Symbols reflect not only practical processes but also philosophical and metaphysical frameworks, enriching archaeological interpretations. However, their cross-cultural significance poses challenges, as overreliance on symbolic meanings may lead to speculative conclusions. Thus, archaeologists must balance symbolic analysis with empirical evidence, and if possible chemical analyses, ensuring that interpretations remain grounded in material data and context-specific observations.

9.3. How was the alchemist portrayed?



Figure 24: Adriaen van Ostade, Alchemist, 1661, London, National Gallery

9.3.1. The fraudsters

In 17th-century art, alchemists were often mocked through satirical "low-life" genre paintings, depicting them as "puffers", another word for fraudsters, focused on mechanical tasks rather than true wisdom (Rehn, 2011). These depictions, influenced by artists like Adriaen Brouwer (1604-1638),

drew parallels between alchemists and socially marginal figures such as gamblers and quacks. Paintings emphasized disorder, poverty, and moral failure, warning against greed and obsession. Artists like Pieter Bruegel (1559) and Adriaen van Ostade (1610-1685) (see figure 1) used neglected families and chaotic homes to underscore the consequences of misplaced pursuits, reflecting cultural values of frugality, cleanliness, and domestic virtue (Rehn, 2011).

The negative view of alchemists, particularly those focused solely on the mechanical aspects of the craft, was rooted in a broader contempt for manual labor during the seventeenth century. Figures like Robert Boyle (1627-191) and Francis Bacon (1561-1626) criticized these "puffer" alchemists, valuing the philosophical or theoretical dimensions of alchemy over its practical, mechanical pursuits (Rehn, 2011). This perspective reflected a wider cultural trend, where intellectual pursuits were highly esteemed, and manual labor was often seen as beneath social ambition. The distinction between theoretical knowledge and manual work was also mirrored in the art world, where artists distanced themselves from crafts to elevate their social status (Rehn, 2011).



Figure 95: David Teniers, Alchemist at work, Science History Institute digital collections

9.3.2. The scholars

In contrast to the negative depiction of alchemists as "puffers" or fraudsters, as discussed earlier, some paintings also presented a more dignified image of the alchemist, one as a learned scholar engaged in intellectual pursuits (Rehn, 2011). While the "puffer" alchemists were often portrayed in satirical, low-life genre scenes, as figures of moral failure and greed, the scholarly alchemist was typically shown as a serious figure, deeply absorbed in books and study (Rehn, 2011). Artists like David Teniers the Younger (1610-1690) for instance, represented the alchemist sitting at his desk, surrounded by books and symbolic objects such as skulls and hourglasses (see figure 2). In these types of depictions, the alchemist was often portrayed in a private study, in contrast to the chaotic, disorderly settings of the "puffer" alchemist in figure 1, who was frequently shown at a hearth surrounded by clutter and disarray, such as the case between figure 1 and 2 in case 2 also. The scholarly alchemist's study was often neat, though filled with objects like books, globes, and other intellectual symbols that signified his learned status (Rehn, 2011). Unlike the "puffer" alchemists, whose work was seen as fruitless or morally questionable, these scholarly figures were portrayed as dignified and financially comfortable, supported by the luxury of time and resources to pursue their intellectual interests (Rehn, 2011).

This contrast between the "puffer" and scholarly alchemist highlights a broader social distinction in how alchemy was perceived in the seventeenth century. While the practical aspects of alchemy were often seen as a lower, even disreputable pursuit, the scholarly alchemist, was afforded a more respected position (Rehn, 2011). The latter was viewed as contributing to a higher intellectual goal, one that sought to understand the nature of the universe and the processes of matter, rather than merely seeking material gain. In this way, the scholarly alchemist became a more socially acceptable figure, especially for those who could afford to pursue alchemy as a form of intellectual exploration rather than a means of livelihood (Rehn, 2011).

For an archaeologist using images of alchemists to support their material findings, it is important to consider the contrasting portrayals of alchemists in 17th-century art. While some images depict alchemists as "puffers" or fraudsters, focused on mechanical tasks and representing moral failure, others present alchemists as scholarly figures engaged in intellectual pursuits. These scholarly representations, often associated with dignity and intellectual curiosity, suggest a more respected view of alchemy as a pursuit of knowledge, rather than a mere quest for material wealth.

Archaeologists must therefore be mindful of these contrasting representations, as they may influence the interpretation of material remains. As such, an archaeologist must recognize that these artistic representations were influenced by the cultural and social dynamics of the time, which may not accurately reflect the true nature of alchemical practice but rather serve as a moral view or social critique. When using these images to support material finds, it's important to acknowledge the potential bias and satirical nature of such depictions.

9.4. Women in alchemy

Gender plays a significant symbolic role in alchemy, with substances and processes often described using masculine, feminine, or hermaphroditic terms (L. M. Principe, 2008). Alchemical texts and motifs commonly employ language and imagery, depicting the union of male and female elements as a metaphor for achieving transformation and harmony, particularly in the pursuit of the philosopher's stone. This "chemical marriage", a term often used in alchemical studies, symbolized the merging of opposites, sulfur and mercury for example, essential to alchemical theory (Principe, 2008). Understanding the use of gender in alchemy helps contextualize its goals and challenges modern interpretations, emphasizing that these symbolic unions were central to alchemical thought rather than added decorations.

However, throughout this thesis on alchemy, its nature, artifacts, symbolism, and the role of the alchemist, it is striking how absent women have been from the narrative. Women appear underrepresented, if not entirely excluded, both in historical accounts and visual sources. This absence raises questions, as it seems unlikely that women were wholly disconnected from the alchemical traditions. Given the pervasive gender dynamics in historical scholarship, it is plausible that women's contributions were overlooked or deliberately minimized. This gap highlights the need for a more inclusive approach to uncovering women's involvement in the alchemical world.

One of the earliest known practitioners of alchemy was a woman known as Maria Hebraea, Maria the Hebrew or Maria the Jewess (ca. 0-200 CE), whom some would call the founding mother of western alchemy (Patai, 1982). Maria was the inventor of the alchemical apparatuses *kerotakis*, an apparatus used for prolonged boiling of liquids. It operates through a process known as reflux, where the vapor from the boiling liquid condenses in the upper part of the device and returns to the original vessel,

allowing continuous heating without loss of material. This technique was essential in early chemistry for achieving more efficient distillation and extraction (Bostrup, 2017; Lewis, 2019).

Her legacy endures through two important terms in chemistry and daily life. The *bain-marie*, a water-bath technique used to maintain a consistent temperature, is named after her and remains common in cooking and laboratory settings to this day (Lewis, 2019). This method ensures gentle, controlled heating, much like a double boiler. Additionally, *Mary's black*, a black sulfide coating on metals, is attributed to her innovations using the kerotakis apparatus (Lewis, 2019). These associations not only highlight her contributions, but also underscore how her techniques bridged alchemical practices and modern applications, emphasizing her lasting impact despite the historical underrepresentation of women in alchemy.

Women's roles in alchemy in other words, though historically overlooked, are crucial for archaeologists seeking a comprehensive understanding of the field. Investigating women's involvement can provide valuable insights not only into knowledge production, access, and the transmission of esoteric practices, but similarly to the case of Maria the Jewess, it is also essential to understand the development of chemical science and its tools, thereby gaining insight into the knowledge and objects we have today. Acknowledging women's participation enriches archaeological studies by highlighting diverse contributors and encouraging a more balanced narrative of alchemy's evolution.

9.5. Engaging with or challenging modern narratives

As an archaeologist studying alchemy and its material evidence, engaging with or challenging modern narratives is essential for several reasons. First, the traditional historiography of alchemy has often been shaped by modern biases that overlook the complexity of alchemical practices and the diverse range of participants involved (Martín-Torres, 2011).

Modern narratives often portray alchemy as a precursor to modern chemistry, emphasizing its "failure" to produce actual practical results. However, this view tends to diminish the spiritual, philosophical, and symbolic aspects of alchemy that were central to its practitioners (Newman, 2011; Principe, 2013). As archaeologists, by focusing on material evidence such as alchemical equipment

like crucibles and glassware, we can challenge this simplistic approach. Furthermore, gender dynamics in alchemy have been largely overlooked in mainstream accounts. As alchemical imagery and texts often contained gendered metaphors, such as the "chemical marriage" of male and female elements (Principe, 2008), archaeologists can help challenge the historical exclusion of women in the narrative of alchemy. Women like Maria the Jewess, who we now know contributed to the development of early laboratory equipment, are often marginalized, and their contributions are often overshadowed by the predominantly male figures of alchemy. By critically engaging with material culture, archaeology can shed light on these overlooked voices, and emphasize the active roles women played in the alchemical tradition (Patai, 1982).

Additionally, modern interpretations of alchemy frequently ignore the cultural and social contexts of its practice. In antiquity and the medieval period, alchemy was deeply embedded in the intellectual and spiritual movements of the time, such as the Hermetic tradition (Gray, 2014). Archaeological evidence of alchemical tools, inscriptions, and even the locations of workshops can provide critical insights into how alchemy functioned within broader societal and religious frameworks, rather than just as an isolated precursor to modern science (Gray, 2014; Newman, 2011; Newman & Principe, 1998).

Finally, engaging with and challenging modern narratives in the study of alchemy, allows archaeologists to reconsider the influence of alchemical practices on the development of early science. The material evidence of alchemical laboratories, tools, written and visual sources, can clarify how alchemists experiment with substances contributed to the eventual rise of chemistry and medicine, even if their spiritual goals were different from the way we understand modern scientific practices today.

Conclusion

This thesis has sought to explore the underrepresentation of alchemy in contemporary archaeological discussions, addressing a fundamental gap in the understanding of alchemy's material traces and its role in early modern scientific practices. Despite its historical significance and widespread influence, alchemy has largely been absent from archaeological interpretations, particularly within the contexts of Danish materials and the broader international archaeological community. This study hypothesized that the absence of alchemy in archaeological records is not necessarily due to a lack of material evidence but rather to result of misinterpretation, lack of recognition, and insufficient contextual understanding of the objects and symbols associated with alchemical practices.

Through the examination of case studies such as the Jamestown Colony in America, Oberstockstall in Austria, and Kværnhusbroen in Denmark, this thesis has demonstrated, that material evidence for alchemy does indeed exist. Artifacts like crucibles, glassware, distillation equipment, and alchemical symbols, which have often been overlooked or misidentified as mundane objects, carry significant insights into alchemical practices. The focus on specific materials, tools, and contextual evidence has revealed, that alchemy's material culture is not as scarce as previously thought. Instead, the challenge lies in recognizing the distinctive nature of these artifacts and understanding their role within alchemical practices, particularly given their symbolic, esoteric, and often mystical dimensions.

Furthermore, this thesis argues that the underrepresentation of alchemy is not a localized issue within Danish archaeology, but reflects a broader trend in international scholarship. While scholars is increasingly acknowledging the intellectual contributions of alchemy to the development of modern science, the material evidence tied to these practices remains underexplored in an archaeological contexts. This lack of engagement with alchemical material culture can be attributed to both a limited understanding of the specific tools and symbols associated with alchemy, and a tendency to underestimate alchemy's role in shaping the material world, particularly in terms of early experimental science and metallurgy.

In conclusion, the absence of alchemy from contemporary archaeological discussions, can be traced to both interpretive challenges and a broader historical lack of attention on alchemical practices. Archaeologists, prepared with an understanding of alchemical symbolism and the historical context of these practices, can unearth a wealth of material evidence that sheds light on the intellectual,

spiritual, and experimental aspects of early modern alchemy. The findings of this thesis suggest that alchemical material culture, far from being absent, is often concealed within objects that require specialized knowledge and interpretation. Moving forward, a more nuanced and integrated approach to alchemy in archaeological research will not only enrich our understanding of early modern science but also highlight the interconnectedness of material culture, philosophy, and spiritual practice in shaping the intellectual landscapes of the past.

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